

DRAFT

RCRA Facility Investigation – Remedial Investigation/
Corrective Measures Study – Feasibility Study Report
for the Rocky Flats Environmental Technology Site
Appendix A – Comprehensive Risk Assessment

Volume 13 of 15
Risk Assessment for the Southeast Buffer Zone Area
Exposure Unit

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ACRONYMS AND ABBREVIATIONS

| | |
|---------|--|
| µg/kg | microgram per kilogram |
| µg/L | microgram per liter |
| AEU | Aquatic Exposure Unit |
| AI | adequate intake |
| bgs | below ground surface |
| BZ | Buffer Zone |
| CAD/ROD | Corrective Action Decision/Record of Decision |
| CD | compact disc |
| CDPHE | Colorado Department of Public Health and Environment |
| cfs | cubic feet per second |
| CMS | Corrective Measures Study |
| CNHP | Colorado Natural Heritage Program |
| COC | contaminant of concern |
| CRA | Comprehensive Risk Assessment |
| DOE | U.S. Department of Energy |
| DQA | Data Quality Assessment |
| DQO | data quality objective |
| DRI | dietary reference intake |
| ECOI | ecological contaminant of interest |
| ECOPC | ecological contaminant of potential concern |
| EPA | U.S. Environmental Protection Agency |
| EPC | exposure point concentration |
| ERA | Ecological Risk Assessment |
| ESL | ecological screening level |

| | |
|--------------|--|
| EU | Exposure Unit |
| HHRA | Human Health Risk Assessment |
| HRR | Historical Release Report |
| IA | Industrial Area |
| IAG | Interagency Agreement |
| IHSS | Individual Hazardous Substance Site |
| kg | kilogram |
| LOAEL | lowest observed adverse effect level |
| LOEC | lowest effects concentration |
| LWOEU | Lower Woman Drainage Exposure Unit |
| MDC | maximum detected concentration |
| mg | milligram |
| mg/day | milligram per day |
| mg/kg | milligram per kilogram |
| mg/kg/BW/day | milligram per kilogram receptor body weight per day |
| mg/l | milligram per liter |
| mL | milliliter |
| mL/day | milliliter per day |
| N/A | not applicable or not available |
| NFA | No Further Action |
| NFAA | No Further Accelerated Action |
| NOAEL | no observed adverse effect level |
| OU | Operable Unit |
| PAC | Potential Area of Concern |
| PARC | precision, accuracy, representativeness, completeness, and comparability |

| | |
|-------|---|
| PCB | polychlorinated biphenyl |
| pCi | picocurie |
| pCi/g | picocuries per gram |
| pCi/L | picocuries per liter |
| PCOC | potential contaminant of concern |
| PMJM | Preble's meadow jumping mouse |
| PRG | preliminary remediation goal |
| QAPjP | Quality Assurance Project Plan |
| QA/QC | quality assurance/quality control |
| RCEU | Rock Creek Drainage Exposure Unit |
| RCRA | Resource Conservation and Recovery Act |
| RDA | recommended daily allowance |
| RDI | recommended daily intake |
| RFCA | Rocky Flats Cleanup Agreement |
| RFETS | Rocky Flats Environmental Technology Site |
| RI/FS | Remedial Investigation/Feasibility Study |
| SAP | Sampling and Analysis Plan |
| SCM | site conceptual model |
| SEEU | Southeast Buffer Zone Area Exposure Unit |
| SEP | Solar Evaporation Ponds |
| SWEU | Southwest Buffer Zone Area Exposure Unit |
| tESL | threshold ESL |
| TRV | toxicity reference value |
| UBC | Under Building Contamination |
| UCL | upper confidence limit |

| | |
|-----|---------------------------|
| UL | upper limit daily intake |
| UT | uncertain toxicity |
| UTL | upper tolerance limit |
| VOC | volatile organic compound |
| WRS | Wilcoxon Rank Sum |
| WRV | wildlife refuge visitor |
| WRW | wildlife refuge worker |

EXECUTIVE SUMMARY

This report presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the 579-acre Southeast Buffer Zone (BZ) Exposure Unit (EU) (SEEU) at the Rocky Flats Environmental Technology Site (RFETS). The purpose of this report is to assess potential risks to human health and ecological receptors posed by exposure to contaminants of concern (COCs) and ecological contaminants of potential concern (ECOPCs) remaining at the SEEU after completion of accelerated actions at RFETS.

Results of the COC selection process for the HHRA indicate that no COCs were selected and there are no significant human health risks from RFETS-related operations at the SEEU. As a result, potential health risks for the wildlife refuge worker (WRW) and wildlife refuge visitor (WRV) are expected to be within the range of background risks. The estimated cancer risks for the WRW and WRV associated with potential exposure to background levels of naturally occurring metals in surface soil/surface sediment are both approximately $2\text{E-}06$. The estimated noncancer hazard indices associated with potential exposure to background levels of metals in surface soil/surface sediment are approximately 0.3 for the WRW and 0.1 for the WRV.

In the ERA, no ECOPCs in surface soil were identified for non-Preble's jumping mouse (PMJM) receptors and no ECOPCs in subsurface soil were identified for burrowing receptors. No PMJM receptors were evaluated in the SEEU. The small areas of PMJM habitat were evaluated as part of the Southwest Buffer Zone Area Exposure Unit (SWEU) and the Lower Woman Drainage Exposure Unit (LWOEU). The ECOPC identification process constitutes a screening level risk assessment. Because this process did not identify any ECOPCs in the SEEU, risks to ecological receptors from site-related contaminants are likely to be negligible in this EU.

1.0 SOUTHEAST BUFFER ZONE EXPOSURE UNIT

This volume of the Comprehensive Risk Assessment (CRA) presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the Southeast Buffer Zone (BZ) Area Exposure Unit (EEU) (SEEU) at the Rocky Flats Environmental Technology Site (RFETS) (Figure 1.1).

The HHRA and ERA methods and selection of receptors are described in detail in the Final CRA Work Plan and Methodology (DOE 2005a), hereafter referred to as the CRA Methodology. A summary of the risk assessment methods, including updates made in consultation with the regulatory agencies, are summarized in Appendix A, Volume 2, Section 2.0 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation (RI)/Corrective Measures Study (CMS)-Feasibility Study (FS) Report (hereafter referred to as the RI/FS Report). The anticipated future land use of RFETS is a wildlife refuge. Two human receptors, a wildlife refuge worker (WRW) and a wildlife refuge visitor (WRV), are evaluated in this risk assessment consistent with this land use. A variety of representative terrestrial and aquatic receptors are evaluated in the ERA including the Preble's meadow jumping mouse (PMJM), a federally listed threatened species present at the RFETS.

1.1 Southeast Buffer Zone Exposure Unit Description

This section provides a brief description of the SEEU, including its location at RFETS, historical activities in the area, topography, surface water features, vegetation, and ecological resources. A more detailed description of these features and additional information regarding the geology, hydrology, and soil types at RFETS is included in Section 2.0, Site Physical Characteristics, of the RI/FS Report. This information is also summarized in Appendix A, Volume 2 of the RI/FS Report.

The Historical Release Report (HRR) (DOE 1992) and its annual updates provide descriptions of known or suspected releases of hazardous substances that occurred at RFETS. The original HRR organized these known or suspected historical sources of contamination as Individual Hazardous Substance Sites (IHSSs), Potential Areas of Concern (PACs), or Under Building Contamination (UBC) sites (hereafter referred to as IHSSs). Individual historical IHSSs and groups of historical IHSSs were also designated as Operable Units (OUs). Over the course of cleanup under the 1991 Interagency Agreement (IAG) and the 1996 (Rocky Flats Cleanup Agreement), the U.S. Department of Energy (DOE) has thoroughly investigated and characterized contamination associated with these IHSSs. IHSSs have been dispositioned through appropriate remedial actions or by determining that No Further Accelerated Action (NFAA) is required, pursuant to the applicable IAG and RFCA requirements. Some OUs have also been dispositioned in accordance with an OU-specific Corrective Action Decision/Record of Decision (CAD/ROD).

A more detailed description of the OU and IHSS history at RFETS is included in Section 1.0, Site Background, of the RI/FS Report. This information is also briefly summarized in Appendix A, Volume 2 of the RI/FS Report.

One historical IHSS exists within the SEEU: Roadway Spraying (PAC 000-501) (Table 1.1 and Figure 1.2). PAC 000-501 was proposed for No Further Action (NFA) in 1991 and the NFA was approved in 2002 as documented in the 2002 HRR Update (DOE 2002).

1.1.1 Exposure Unit Characteristics and Location

The 579-acre SEEU is located in the southeastern portion of RFETS (Figure 1.1) and contains the following distinguishing features:

- The SEEU is located within the BZ OU and is outside areas that were used historically for operation of RFETS.
- There have been no significant releases within the SEEU boundaries. A short stretch of gravel road in the SEEU makes up a small portion of PAC 000-501, which was approved for NFA. The SEEU is located generally crosswind and hydraulically cross-gradient relative to the Industrial Area (IA).
- The SEEU includes the Smart Ditch Drainage, a minor drainage that includes two small ponds in the far southern section of RFETS. The drainage does not receive runoff from the IA.

The SEEU is bounded by the Southwest BZ Area EU (SWEU) to the west, the Lower Woman Drainage EU (LWOEU) to the north, and Indiana Street to the east. The property south of the SEEU is privately owned and is used for grazing.

1.1.2 Topography and Surface Water Hydrology

The SEEU is located on an eroded edge of an alluvial terrace. Natural surface water drainage is to the east. The principal surface water features in the SEEU are Smart Ditch and Ponds D-1 and D-2 (Figures 1.2 and 1.3). Smart Ditch¹ is a privately owned irrigation ditch in the southern portion of the BZ OU. The ditch does not receive runoff from the IA. Water from Rocky Flats Lake, located off site and west of the RFETS boundary, flows through Smart Ditch to a splitter box located where the ditch first crosses the SEEU northern boundary. The splitter box diverts water toward the southeast, away from the main channel of Woman Creek, and into Ponds D-1 and D-2. Overland runoff is also intercepted and conveyed by Smart Ditch. Smart Ditch is typically dry, although it has an estimated capacity of 10 cubic feet per second (cfs). Because the ditch is hydrologically separated and far-removed from the IA, limited flow and water quality data exist for this conveyance. An additional ephemeral drainage known as Dogleg Draw is present in the southwestern portion of the SEEU.

¹ Smart Ditch is referred to as Smart Ditch I. Smart Ditch II runs northeast of Rocky Flats Lake (located west of the SEEU) and is used to flood-irrigate a pasture west of RFETS.

The SEEU functioned mainly as a security buffer for the site. Gravel roads in the area are used for security patrols and provide access for surface water management and environmental monitoring activities.

1.1.3 Flora and Fauna

Vegetation in the SEEU is mainly comprised of grasslands. The major components are reclaimed grasslands and mesic mixed grasslands (Figure 1.4). Reclaimed grasslands are located in the southeastern half of the EU and are dominated by two introduced grass species, smooth brome (*Bromus inermis*) and intermediate wheatgrass (*Agropyron intermedium*). The mesic mixed grassland is comprised of western wheatgrass (*Agropyron smithii*), blue grama (*Bouteloua gracilis*), side-oats grama (*Bouteloua curtipendula*), prairie junegrass (*Koeleria pyramidata*), Canada bluegrass (*Poa compressa*), Kentucky bluegrass (*Poa pratensis*), green needlegrass (*Stipa virigula*), and little bluestem (*Andropogon scoparius*). Xeric grasslands occur on pediment areas and small areas of wetland and riparian woodland are found along Smart Ditch and the D-series ponds.

Grasslands are important to wildlife, and grassland conditions on the eastern side of RFETS including SEEU are considered good habitat, although weeds and introduced grass species have degraded grasslands in some areas (PTI 1997b). Weed control, erosion control, and ongoing reclamation activities within the EU will continue to promote native grasslands (Nelson 2005).

Numerous animal species have been observed at RFETS and the more common species are expected to be present in the SEEU. Common large and medium-sized mammals likely to live at or frequent the SEEU include mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), and desert cottontail (*Sylvilagus audubonii*). The most common reptile observed at RFETS is the western prairie rattlesnake (*Crotalis viridus*). Common bird species include meadowlark (*Sturnella neglecta*) and vesper sparrow (*Pooecetes gramineus*). Herons and ducks frequent the D-1 and D-2 ponds. The most common small mammal species include deer mice (*Peromyscus maniculatus*), prairie voles (*Microtus ochrogaster*), meadow voles (*Microtus pennsylvanicus*), and two species of harvest mice (*Reithrodontomys* sp.).

The PMJM is a federally-listed threatened species found at RFETS. The preferred habitat for the PMJM is the riparian corridors bordering streams, ponds, and wetlands at RFETS, with an adjacent thin band of upland grasslands. PMJM habitat occurs along Smart Ditch in the northwestern portion of the SEEU (Figure 1.5). No PMJM have ever been captured within the boundaries of SEEU. As shown on Figure 1.5, portions of three distinct habitat patches are located within the boundaries of the SEEU (#28, #29A, and #30). Because PMJM habitat extends into two bordering EUs, habitat patch #28 will be addressed in the Lower Woman Drainage EU (LWOEU) and habitat patches #29A and #30 will be addressed in the SWEU.

More detail on the species that use RFETS habitats and the methodology of creating sitewide PMJM habitat patches can be found in Appendix A, Volume 2, Section 3.2 of the RI/FS Report.

1.1.4 Data Description

Data have been collected at RFETS under regulatory agency-approved Work Plans, Sampling and Analysis Plans (SAPs), and Quality Assurance Project Plans (QAPjPs) to meet data quality objectives (DQOs) and appropriate U.S. Environmental Protection Agency (EPA) and Colorado Department of Public Health and Environment (CDPHE) guidance. Surface soil, subsurface soil, surface sediment, subsurface sediment, and groundwater samples were collected from the SEEU. Surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil are the media evaluated in the HHRA and ERA (Table 1.2). The sampling locations for these media are shown on Figures 1.6 and 1.7, and data summaries for detected analytes in each medium are provided in Tables 1.3 through 1.7. Potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) that were analyzed for but not detected, or were detected in less than 5 percent of the samples, are presented in Attachment 1. Detection limits are compared to preliminary remediation goals (PRGs) and ecological screening levels (ESLs) and discussed in Attachment 1 (Tables A1.1 through A1.4). Only data from June 1991 to the present are used in the CRA because these data meet the approved analytical quality assurance/quality control (QA/QC) requirements.

In accordance with the CRA Methodology, only data collected on or after June 28, 1991, and data for subsurface soil and subsurface sediment samples with a start depth less than or equal to 8 feet below ground surface (bgs) are used in the CRA. Subsurface soil and subsurface sediment data are limited to this depth because it is not anticipated that the WRW or burrowing animals will dig to deeper depths. A detailed description of data storage and processing methods is provided in Appendix A, Volume 2 of the RI/FS Report. The CRA analytical data set for the SEEU is provided on a compact disc (CD) presented in Attachment 4. The CD includes the data used in the CRA as well as data not considered useable based on criteria presented in Appendix A, Volume 2 of the RI/FS Report.

The sampling data used for the SEEU HHRA and ERA are as follows:

- Combined surface soil/surface sediment data (HHRA);
- Combined subsurface soil/subsurface sediment data (HHRA);
- Surface soil data (ERA); and,
- Subsurface soil data (ERA).

These data for these media are briefly described below.

Surface water and sediment are assessed for ecological receptors on an Aquatic Exposure Unit (AEU) basis in Appendix A, Volume 15B of the RI/FS Report. An assessment of the surface water, groundwater-to-surface water, and volatilization pathways for human health are presented in Appendix A, Volume 2 of the RI/FS Report.

Surface Soil/Surface Sediment

The combined surface soil/surface sediment data set for SEEU consists of up to 55 samples for various analyte groups. The SEEU surface soil/surface sediment samples were analyzed for inorganics (up to 22 samples), organics (up to one sample), and radionuclides (up to 55 samples) (Table 1.2). The surface soil/surface sediment data set includes data from three shallow sediment sampling locations shown on Figure 1.6. The sediment samples were collected to depths less than 0.5 feet from the sediment surface. The samples were collected in the SEEU over several months from July 1991 through September 1994, and then again in March, April, and December of 2004, and January 2005. The samples collected in 2004 were located on a 30-acre grid, as described in CRA SAP Addendum #04-01 (DOE 2004). For the grid sampling, five individual samples were collected from each 30-acre cell, one from each quadrant and one in the center, as described in the Addendum (DOE 2004). Most of the evenly spaced surface soil sampling locations on Figure 1.6 represent the 30-acre grid samples.

The data summary for detected analytes in surface soil/surface sediment for the SEEU is presented in Table 1.3. Detected analytes include representatives from the inorganic, organic, and radionuclide analyte groups. A summary of analytes that were not detected or detected in less than 5 percent of surface soil/surface sediment samples in the SEEU is presented and discussed in Attachment 1.

Subsurface Soil/Subsurface Sediment

Subsurface soil samples used in the CRA are defined in the CRA Methodology as soil samples with a starting depth less than or equal to 8 feet bgs and an ending depth below 0.5 feet. The combined subsurface soil/subsurface sediment data set for SEEU consists of up to nine samples for various analyte groups. The subsurface soil/subsurface sediment data set includes data from one deep sediment sampling location shown on Figure 1.7. The SEEU subsurface soil/subsurface sediment samples were analyzed for inorganics (up to seven samples), organics (up to seven samples), and radionuclides (up to nine samples) (Table 1.2). Subsurface soil/subsurface sediment samples were collected in the SEEU in February 1992, July and August 1994, and again in January 2005.

The data summary for detected analytes in subsurface soil/subsurface sediment for the SEEU is presented in Table 1.4. Detected analytes include representatives from the inorganic, organic, and radionuclide analyte groups. A summary of analytes that were not detected or detected in less than 5 percent of subsurface soil/subsurface sediment samples in the SEEU is presented and discussed in Attachment 1.

Surface Soil

The surface soil data set for SEEU consists of up to 52 samples for various analyte groups. The SEEU surface soil samples were analyzed for inorganics (up to 19 samples),

organics (up to one sample), and radionuclides (up to 52 samples) (Table 1.2). The samples were collected in the SEEU over several months from July 1991 through September 1994, and then again in March and April of 2004. Sample locations are shown on Figure 1.6. The samples collected in 2004 were located on a 30-acre grid, as described in CRA SAP Addendum #04-01 (DOE 2004). For the grid sampling, five individual samples were collected from each 30-acre cell, one from each quadrant and one in the center, as described in the Addendum (DOE 2004). Most of the evenly spaced surface soil sampling locations on Figure 1.6 represent the 30-acre grid samples.

The data summary for detected analytes in SEEU surface soil is presented in Table 1.5, while the data summary for the detected analytes for those samples within designated PMJM habitat is presented in Table 1.6. Radionuclides and inorganics were detected in SEEU surface soil samples. A summary of analytes that were either not detected, or detected in less than 5 percent of surface soil samples in the SEEU is presented and discussed in Attachment 1.

Subsurface Soil

Subsurface soil samples used in the CRA are defined in the CRA Methodology as soil samples with a starting depth less than or equal to 8 feet bgs and an ending depth below 0.5 feet. The subsurface soil data set for SEEU consists of up to six samples for various analyte groups. The SEEU subsurface soil samples were analyzed for inorganics (up to six samples), organics (up to seven samples), and radionuclides (up to eight samples) (Table 1.2). The samples were collected in the SEEU in February 1992, and again in July and August 1994. Sample locations are shown on Figure 1.7.

The data summary for detected analytes in subsurface soil for the SEEU is presented in Table 1.6. Subsurface soil samples were analyzed for inorganics, organics, and radionuclides, and representatives from all three analyte groups were detected. A summary of analytes that were either not detected, or detected in less than 5 percent of subsurface soil samples in the SEEU is presented and discussed in Attachment 1.

1.2 Data Adequacy Assessment

A data adequacy assessment was performed to determine whether the available data set discussed in the previous section is adequate for risk assessment purposes. The data adequacy assessment rules are presented in the CRA Methodology, and a detailed data adequacy assessment for the data used in the CRA is presented in Appendix A, Volume 2 of the RI/FS Report. The adequacy of the data was assessed by examining the number of available samples for each analyte group in each medium for use in the CRA, the spatial and temporal representativeness of the data, as well as information on potential historical sources of contamination, migration pathways, and the concentration levels in the media. The assessment concludes that the data are adequate for the purposes of the CRA.

1.3 Data Quality Assessment

A Data Quality Assessment (DQA) of the SEEU data was conducted to determine whether the data were of sufficient quality for risk assessment use. The DQA is presented

in Attachment 2, and an evaluation of the entire RFETS data set is presented in Appendix A, Volume 2 of the RI/FS Report. The quality of the laboratory results were evaluated for compliance with the CRA Methodology data quality objectives (DQOs) through an overall review of precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. This review concluded that the data are of sufficient quality for use in the CRA, and the CRA DQOs have been met.

2.0 SELECTION OF HUMAN HEALTH CONTAMINANTS OF CONCERN

The human health contaminant of concern (COC) screening process is described in Section 4.4 of the CRA Methodology and summarized in Appendix A, Volume 2 of the RI/FS Report (Section 2.2).

The human health COC selection process was conducted for surface soil/surface sediment and subsurface soil/subsurface sediment in the SEEU. Results of the COC selection process are summarized below.

2.1 Contaminant of Concern Selection for Surface Soil/Surface Sediment

Detected PCOCs in surface soil/surface sediment samples (Table 1.3) are screened in accordance with the CRA Methodology to identify the COCs.

2.1.1 Surface Soil/Surface Sediment Cation/Anion and Essential Nutrient Screen

The major cations and anions that do not have toxicity criteria are eliminated from assessments in surface soil/surface sediment in accordance with the CRA Methodology.

The essential nutrient screen for analytes detected in surface soil/surface sediment is presented in Table 2.1. The screen includes PCOCs that are essential for human health and do not have toxicity criteria available. Table 2.1 shows the maximum detected concentrations (MDCs) for essential nutrients, daily intake estimates based on the MDCs, and dietary reference intakes (DRIs). The DRIs are identified in the table as recommended daily allowances (RDAs), recommended daily intakes (RDIs), adequate intakes (AIs), and upper limit daily intakes (ULs). The estimated daily maximum intakes based on the nutrients' MDCs and a surface soil/surface sediment ingestion rate of 100 milligrams (mg) per day (mg/day) are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for surface soil/surface sediment.

2.1.2 Surface Soil/Surface Sediment Preliminary Remediation Goals Screen

Table 2.2 compares the MDCs and upper confidence limits (UCLs) to the WRW PRGs for each PCOC. If the MDC and the UCL are greater than the PRG, the PCOC is retained for further screening; otherwise, is not further evaluated. Arsenic and manganese were the only analytes in surface soil/surface sediment that had an MDC and UCL that exceeded the PRG and were retained as PCOCs. Cesium-137 and radium-228 were also retained as a PCOC because the MDCs exceeded the PRGs. A comparison of the UCLs

for cesium-137 and radium-228 could not be performed because an UCL could not be calculated based on the number of samples.

PRGs were not available for several PCOCs in surface soil/surface sediment. Analytes without PRGs are listed on Table 2.2 and their effect on the conclusions of the risk assessment results is discussed in the uncertainty section (Section 6.0).

2.1.3 Surface Soil/Surface Sediment Detection Frequency Screen

Arsenic and manganese were detected in more than 5 percent of surface soil/surface sediment samples (Table 1.3) and, therefore, were retained for further evaluation in the COC screen. A detection frequency screen was not performed for cesium-137 and radium-228 in surface soil/surface sediment because all reported values for radionuclides are considered detects.

2.1.4 Surface Soil/Surface Sediment Background Analysis

Results of the background statistical comparison for arsenic, manganese, cesium-137, and radium-228 are presented in Table 2.3 and discussed in Attachment 3. Boxplots for arsenic and manganese (both SEEU and background) are provided in Attachment 3. Arsenic and manganese were statistically greater than background at the 0.1 significance level, and are evaluated further in the professional judgment section.

A background analysis could not be performed for cesium-137 and radium-228 based on the number of samples. Therefore, cesium-137 and radium-228 are evaluated further in the professional judgment section.

2.1.5 Surface Soil/Surface Sediment Professional Judgment Evaluation

Based on the weight of available evidence evaluated by professional judgment, PCOCs will either be included for further evaluation as COCs or excluded as COCs. The professional judgment evaluation takes into account process knowledge, spatial trends, pattern recognition, comparisons to RFETs background and other background data sets, and risk potential. As discussed in Section 1.2 and Attachment 2, the sample results are adequate for use in the professional judgment because they are of sufficient quality for use in the CRA.

Based on the weight of evidence described in Attachment 3, arsenic, manganese, cesium-137, and radium-228 in surface soil/surface sediment in the SEEU are not considered COCs because the weight of evidence supports the conclusion that arsenic, manganese, cesium-137, and radium-228 concentrations in surface soil/surface sediment in the SEEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations.

2.2 Contaminant of Concern Selection for Subsurface Soil/Subsurface Sediment

Detected PCOCs in subsurface soil/subsurface sediment samples (Table 1.4) are screened in accordance with the CRA Methodology to identify the COCs.

2.2.1 Subsurface Soil/Subsurface Sediment Cation/Anion and Essential Nutrient Screen

The major cations and anions that do not have toxicity criteria were eliminated from assessments in subsurface soil/subsurface sediment in accordance with the CRA Methodology.

Essential nutrients without toxicity criteria that were detected in subsurface soil/subsurface sediment at the SEEU were compared to DRIs in Table 2.4. The estimated daily maximum intakes for these PCOCs, based on the nutrient's MDCs and a subsurface soil/subsurface sediment ingestion rate of 100 mg/day, are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for subsurface soil/subsurface sediment.

2.2.2 Subsurface Soil/Subsurface Sediment Preliminary Remediation Goal Screen

The PRG screen for detected analytes in subsurface soil/subsurface sediment is presented in Table 2.5. The MDC and UCL for radium-228 in subsurface soil/subsurface sediment were greater than the PRG and, therefore, radium-228 was retained for further evaluation in the COC selection process in the SEEU.

PRGs were not available for several PCOCs in subsurface soil/subsurface sediment. Analytes without PRGs are listed on Table 2.5 and their effect on the conclusions of the risk assessment results is discussed in the uncertainty section (Section 6.0).

2.2.3 Subsurface Soil/Subsurface Sediment Detection Frequency Screen

The detection frequency screen was not performed for radium-228 in subsurface soil/subsurface sediment because all reported values for radionuclides are considered detects.

2.2.4 Subsurface Soil/Subsurface Sediment Background Analysis

Analyses were conducted to assess whether radium-228 concentrations in SEEU subsurface soil/subsurface sediment are statistically higher than those in background subsurface soil/subsurface sediment at the 0.1 level of significance (1-p less than or equal to 0.1). The subsurface soil/subsurface sediment background data are described in detail in Appendix A, Volume 2 of the RI/FS Report.

The results of the statistical comparisons of the SEEU data to the background data indicate site activity for radium-228 is not statistically greater than background at the 0.1 significance level. The results are summarized in Table 2.3 and in Attachment 3. Boxplots for radium-228 (both SEEU and background) are provided in Attachment 3. Radium-228 in subsurface soil/subsurface sediment is not further evaluated in the COC screening process.

2.2.5 Subsurface Soil/Subsurface Sediment Professional Judgment Evaluation

The professional judgment step was not performed for subsurface soil/subsurface sediment because there were no PCOCs with concentrations statistically greater than background concentrations.

2.3 Contaminant of Concern Selection Summary

A summary of the results of the COC screening process is presented in Table 2.6. No COCs were selected for any of the media at the SEEU.

3.0 HUMAN HEALTH EXPOSURE ASSESSMENT

The site conceptual model (SCM), presented in Figure 2.1 of the CRA Methodology and discussed in Appendix A, Volume 2 of the RI/FS Report, provides an overview of potential human exposures at RFETS for reasonably anticipated land use. However, all PCOCs were eliminated from further consideration as human health COCs for the SEEU based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). A quantitative risk characterization is not necessary for the SEEU and, therefore, an exposure assessment was not conducted.

4.0 HUMAN HEALTH TOXICITY ASSESSMENT

Procedures and assumptions for the toxicity assessment are presented in the CRA Methodology. All PCOCs were eliminated from further consideration as human health COCs for the SEEU based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). A quantitative risk characterization is not necessary for the SEEU and, therefore, a toxicity assessment was not conducted.

5.0 HUMAN HEALTH RISK CHARACTERIZATION

Information from the exposure assessment and the toxicity assessment is integrated in this section to characterize risk to the WRW and WRV receptors. All PCOCs were eliminated from further consideration as human health COCs based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). Therefore, a quantitative risk characterization was not performed for the SEEU.

6.0 UNCERTAINTIES ASSOCIATED WITH THE HUMAN HEALTH RISK ASSESSMENT

There are various types of uncertainties associated with steps of an HHRA. General uncertainties common to the EUs are discussed in Appendix A, Volume 2 of the RI/FS Report. Uncertainties specific to the EU are described below.

6.1 Uncertainties Associated With the Data

Data adequacy for this CRA is evaluated and discussed in Appendix A, Volume 2 of the RI/FS Report. Although there are some uncertainties associated with the sampling and analyses conducted for surface soil/surface sediment and subsurface soil/subsurface sediment at the SEEU, data are considered adequate for the characterization of risk at the EU. The environmental samples for the SEEU were collected from 1991 through 2004. The CRA sampling and analysis requirements for the BZ (DOE 2004, 2005a) specify that the minimum sampling density requirement for surface soil/surface sediment is one five-sample composite for every 30-acre grid cell. In surface soil/surface sediment, there are up to 55 samples in the SEEU. Although there is limited data for organics in surface soil/surface sediment, there are no known or suspected sources for organic contaminants in the SEEU. In subsurface soil/subsurface sediment, there are up to nine samples in the SEEU.

Another source of uncertainty in the data is the relationship of detection limits to the PRGs for analytes eliminated as COCs because they were not detected or had a low detection frequency (i.e., less than 5 percent). The detection limits were appropriate for the analytical methods used, and this is examined in greater detail in Attachment 1.

6.2 Uncertainties Associated With Screening Values

The COC screening analyses utilized RFETS-specific PRGs based on a WRW scenario. The assumptions used in the development of these values were conservative. For example, it is assumed that a future WRW will consume 100 mg of surface soil/surface sediment for 230 days per year for a period of 18.7 years. In addition, a WRW is assumed to be dermally exposed to and inhale surface soil and surface sediment particles in the air. These assumptions are likely to overestimate actual exposures to surface soil for WRWs in the SEEU because a WRW will not spend 100 percent of his or her time in this area. Exposure to subsurface soil and subsurface sediment is assumed to occur 20 days per year. The WRW PRGs for subsurface soil/subsurface sediment are also expected to conservatively estimate potential exposures because it is unlikely a WRW will excavate extensively in the SEEU.

6.2.1 Uncertainties Associated with Potential Contaminants of Concern without Preliminary Remediation Goals

PCOCs for the SEEU for which PRGs are not available are listed in Table 6.1.

Uncertainties associated with the lack of PRGs for analytes listed in Table 6.1 are considered small. The listed inorganics are not usually included in HHRA's because they are not expected to result in significant human health impacts. Radionuclide PRGs are available for all detected individual radionuclides. Therefore, the lack of PRGs for the gross alpha and gross beta activities is not expected to affect the results of the HHRA.

6.3 Uncertainties Associated with Eliminating Potential Contaminants of Concern Based on Professional Judgment

Arsenic, manganese, cesium-137, and radium-228 in surface soil/surface sediment were eliminated as COCs based on professional judgment. There is no identified source or pattern of release for these analytes in the SEEU and the slightly elevated median values of arsenic, manganese, cesium-137, and radium-228 in the SEEU are most likely due to natural variation. The weight of evidence presented in Attachment 3, Section 4.0 supports the conclusion that concentrations of arsenic, manganese, cesium-137, and radium-228 are naturally occurring and not due to site activities. Uncertainty associated with the elimination of these chemicals as COCs is low.

No PCOCs were eliminated in subsurface soil/subsurface sediment based on professional judgment in the SEEU.

6.4 Uncertainties Evaluation Summary

Evaluation of the uncertainties associated with the data and the COC screening processes indicates there is reasonable confidence in the conclusions of the SEEU risk characterization.

7.0 IDENTIFICATION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN

The ecological contaminant of potential concern (ECOPC) identification process streamlines the ecological risk characterization for each EU by focusing the assessment on ECOIs that are present in the SEEU. ECOIs are defined as any chemical detected in the SEEU and are assessed for surface soils and subsurface soils. ECOIs for sediments and surface water are assessed in Appendix A, Volume 15 of the RI/FS Report. The ECOPC process is described in the CRA Methodology and additional details are provided in Appendix A, Volume 2 of the RI/FS Report. A detailed discussion of the SCM, including the receptors of concern, exposure pathways, and endpoints used in the ERA for the SEEU, are also provided in Appendix A, Volume 2 of the RI/FS Report.

The process is based on the SCM presented in the CRA Methodology and described in detail in Appendix A, Volume 2 of the RI/FS Report. The SCM presents the pathways of potential exposure from documented historical source areas (IHSSs and PACs) to the receptors of concern. Generally, the most significant exposure pathways for wildlife at the SEEU are the ingestion of plant, invertebrate, or animal tissue that could have accumulated ECOIs from the source areas through direct uptake or dietary routes, as well as the direct contact or ingestion of potentially contaminated media. For terrestrial plants and invertebrates, the most significant pathway is direct contact with potentially contaminated soil.

The receptors of concern that were selected for assessment are listed in Table 7.1, and discussed in detail in Appendix A, Volume 2 of the RI/FS Report, and include representative birds and mammals in addition to the general plant and terrestrial

invertebrate communities. The receptors were selected based on several criteria, including their potential to be found in the various habitats present within RFETS, their potential to come into contact with ECOIs, and the amount of life history and behavioral information available.

The ECOPC process consists of two separate evaluations, one for the PMJM receptor and one for non-PMJM receptors. The ECOPC identification process for the PMJM is conducted separately from non-PMJM receptors because the PMJM is a federally listed threatened species under the Endangered Species Act (63 FR 26517).

7.1 Data Used in the Ecological Risk Assessment

The following SEEU data are used in the CRA:

- Surface soil samples analyzed for inorganics (19 samples), organics (one sample), and radionuclides (52 samples); and
- Subsurface soil samples analyzed for inorganics (six samples), organics (seven samples), and radionuclides (eight samples).

A data summary is provided in Table 1.5 for surface soil and Table 1.6 for subsurface soil.

Sediment and surface water data for the SEEU also were collected (Section 1.1.4) and these data are evaluated for the ERA in Appendix A, Volume 15 of the RI/FS Report.

The SEEU has one sample location occurring in PMJM habitat which is assessed as part of the SWEU PMJM evaluation.

7.2 Identification of Surface Soil Ecological Contaminants of Potential Concern

ECOPCs for surface soil were identified for non-PMJM and PMJM receptors in accordance with the sequence presented in the CRA Methodology.

7.2.1 Comparison with No Observed Adverse Effect Level (NOAEL) Ecological Screening Levels (ESLs)

In the first step of the ECOPC identification process, the MDCs of ECOIs in surface soil were compared to receptor-specific no observed adverse effect level (NOAEL) ESLs. NOAEL ESLs for surface soil were developed in the CRA Methodology for three receptor groups: terrestrial vertebrates, terrestrial invertebrates, and terrestrial plants.

Non-PMJM Receptors

The NOAEL ESLs for non-PMJM receptors are compared to MDCs in surface soil in Table 7.1. The results of the NOAEL ESL screening analyses for all receptor types are

summarized in Table 7.2. Analytes with a “Yes” in any of the “Exceedance” columns in Table 7.2 are evaluated further.

NOAEL ESLs were not available for several ECOI/receptor pairs (Tables 7.1 and 7.2). These ECOI/receptor pairs are discussed as ECOIs with uncertain toxicity (UT) in Section 10.0 along with the potential impacts to the risk assessment.

PMJM Receptors

No screening for PMJM receptors was conducted in the SEEU because the SEEU PMJM habitat is addressed as part of the SWEU PMJM evaluation.

7.2.2 Surface Soil Frequency of Detection Evaluation

The ECOPC identification process for non-PMJM receptors involves an evaluation of detection frequency for each ECOI retained after the NOAEL screening step. If the detection frequency is less than 5 percent, then population-level risks are considered highly unlikely and the ECOI is not further evaluated. None of the chemicals detected in surface soil at the SEEU that were retained after the NOAEL ESL screening step had a detection frequency less than 5 percent. Therefore, no ECOIs were excluded based on the detection frequency evaluation for surface soil in the SEEU.

7.2.3 Surface Soil Background Comparisons

The ECOIs retained after the NOAEL ESL screening and the detection frequency evaluation were then compared to site-specific background concentrations where available. The background comparisons are presented in Table 7.3 and discussed in Attachment 3. The statistical methods used for the background comparison are summarized in the Appendix A, Volume 2, Section 3.2 of the RI/FS Report.

Non-PMJM Receptors

The results of the background comparisons for the non-PMJM receptors are presented in Table 7.3. The analytes listed as being retained as ECOIs in Table 7.3 are evaluated further using upper-bound EPCs in the following section.

PMJM Receptors

No screening for PMJM receptors was conducted in the SEEU because the SEEU PMJM habitat is addressed as part of the LWOEU and SWEU PMJM evaluations.

7.2.4 Upper-Bound Exposure Point Concentration Comparisons to Threshold ESLs (tESLs)

The ECOIs retained after completion of all previous evaluations for non-PMJM receptors were then compared to threshold ESLs (tESLs) using upper-bound exposure point concentrations (EPCs) specific to small and large home-range receptors. The calculation of upper-bound EPCs is described in Appendix A, Volume 2 of the RI/FS.

Statistical concentrations for each ECOI retained for the tESL screen are presented in Table 7.4. The EPC for small home-range receptors is the 95 percent UCL of the 90th

percentile (upper tolerance limit [UTL]), or the MDC in the event that the UTL is greater than the MDC. The EPC for large home-range receptors is the UCL, or the MDC in the event that the UCL is greater than the MDC.

Small home-range receptors include terrestrial plants, terrestrial invertebrates, mourning dove, American kestrel, deer mouse, and black-tailed prairie dog. These receptors are evaluated by comparing the small home-range EPC (UTL) for each ECOI to the limiting (or lowest) small home-range receptor tESL (if available). In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

Large home-range receptors, such as coyote and mule deer, are evaluated by comparing the large home-range EPC (UCL) for each ECOI to the limiting large home-range receptor tESL (if available). In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

The EPC comparison to limiting tESLs for small and large home-range receptors is presented in Table 7.5. Analytes that exceed the limiting tESLs are further evaluated by comparing them to the receptor-specific tESLs (if available) to identify receptors of potential concern. Analytes exceeding the limiting tESLs for small home-range receptors are compared to receptor-specific tESLs in Table 7.6, and analytes exceeding limiting tESLs for large home-range receptors are compared to receptor-specific tESLs in Table 7.7.

Chemicals that exceed any tESLs (if available) are assessed in the professional judgment evaluation. Any analyte/receptor pairs that are retained through professional judgment are identified as ECOPCs and are carried forward in the risk characterization.

7.2.5 Surface Soil Professional Judgment Evaluation

Non-PMJM Receptors

Based on the weight-of-evidence, professional judgment described in Attachment 3, aluminum, boron, chromium, copper, lithium, manganese, molybdenum, nickel, vanadium, and zinc in surface soil at the SEEU were not considered ECOPCs for non-PMJM receptors and are not further evaluated quantitatively.

PMJM Receptors

No professional judgement evaluation was conducted for PMJM receptors in the SEEU.

7.2.6 Summary of Surface Soil Ecological Contaminants of Potential Concern

The ECOPC screening process for surface soil is summarized below for non-PMJM receptors and PMJM receptors.

Non-PMJM Receptors

Inorganic and radionuclide surface soil ECOIs for non-PMJM receptors in the SEEU were eliminated from further consideration as ECOPCs based on one of the following: 1) the MDC of the ECOI was less than the lowest ESL; 2) no ESLs were available (these

ECOIs are discussed in Section 10.0); 3) the concentration of the ECOI in SEEU surface soils was not statistically greater than background surface soils; 4) the upper-bound EPC did not exceed the limiting tESL; or 5) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related contaminant of potential concern. Chemicals that were retained are identified as ECOPCs.

A summary of the ECOPC screening process for non-PMJM receptors is presented in Table 7.10.

PMJM Receptors

No ECOPC identification for PMJM receptors was conducted in the SEEU because the SEEU PMJM habitat is addressed as part of the LWOEU and SWEU PMJM evaluations.

7.3 Identification of Subsurface Soil Ecological Contaminants of Potential Concern

Subsurface soil sampling locations for soil collected at a starting depth of 0.5 to 8 feet bgs in the SEEU are identified on Figure 1.7. A data summary for subsurface soil less than 8 feet deep is presented in Table 1.5.

7.3.1 Comparison to No Observed Adverse Effect Level Ecological Screening Levels

The CRA Methodology indicates subsurface soil is evaluated for those ECOIs that have greater concentrations in subsurface soil than in surface soil. As a conservative screening step, subsurface soil is evaluated for all EUs regardless of the presence/absence of a change in concentrations from surface soil and subsurface soil. The MDCs of ECOIs in subsurface soil were compared to NOAEL ESLs for burrowing receptors (Table 7.8). ECOIs with MDCs greater than the NOAEL ESL for the prairie dog are further evaluated in the ECOPC identification process.

NOAEL ESLs are not available for some analytes, and these are identified as “UT” in Table 7.9. These constituents are considered ECOIs with UT and are discussed in the uncertainty analysis (Section 10).

7.3.2 Subsurface Soil Detection Frequency Evaluation

No 5 percent detection frequency evaluation (Table 7.9) was conducted because only eight subsurface soil samples are available in the SEEU. Therefore, the detection frequency for the analytes that reach this step will always be above 5 percent.

7.3.3 Subsurface Soil Background Comparison

The ECOIs retained after the ESL screening and detection frequency evaluation were compared to site-specific background concentrations where available. The background comparison was conducted in the same manner as that for surface soil non-PMJM receptors using statistical comparisons.

Analyses were conducted to assess whether arsenic in SEEU subsurface soil is statistically greater than those in sitewide background surface soil at the 0.1 level of significance.

The results of the statistical comparisons of the SEEU data to background data indicate that site concentrations of arsenic in SEEU subsurface soil are statistically greater than background concentrations. The results are summarized in Table 7.10.

7.3.4 Upper-Bound Exposure Point Concentration Comparisons to Threshold ESLs

ECOs retained after all previous evaluations for burrowing receptors are compared to tESLs using upper-bound EPCs specific to small home-range receptors. The calculation of upper-bound EPCs is discussed in the Appendix A, Volume 2 of the RI/FS.

Only arsenic was retained following the background analysis step. Statistical concentrations for arsenic are presented in Table 7.11. The EPC comparison to tESLs for burrowing receptors is presented in Table 7.12. The subsurface soil UTL for arsenic is lower than the tESL for the prairie dog receptor; therefore, it was not evaluated further.

7.3.5 Subsurface Soil Professional Judgment

The professional judgment step was not performed for subsurface soils because no ECOs were retained in the previous screening step.

7.3.6 Summary of Subsurface Soil Ecological Contaminants of Potential Concern

All subsurface soil ECOs for burrowing receptors in the SEEU were eliminated from further consideration as ECOPCs based on one of the following: 1) the MDC of the ECOI was less than NOAEL ESL for the burrowing receptor; 2) no ESLs were available (these ECOs are discussed in Section 10.0); 3) the concentration of the ECOI in SEEU subsurface soils was not statistically greater than background subsurface soils; or 4) the upper-bound EPC was less than the tESL. The results of the subsurface soil ECOPC identification process for burrowing receptors are summarized in Table 7.13.

7.4 Summary of Ecological Contaminants of Potential Concern

ECOs in surface and subsurface soil in the SEEU were evaluated in the ECOPC identification process for non-PMJM receptors and burrowing receptors. No chemicals were identified as ECOPCs for non-PMJM receptors (Table 7.8). No chemicals were identified as ECOPCs for burrowing receptors (Table 7.13).

8.0 ECOLOGICAL EXPOSURE ASSESSMENT

The ECOPC identification steps did not identify any ECOPCs for either surface or subsurface soil in the SEEU. Therefore, no exposure assessment was performed for the SEEU.

9.0 ECOLOGICAL TOXICITY ASSESSMENT

The ECOPC identification steps did not identify any ECOPCs for either surface or subsurface soil in the SEEU. Therefore, no toxicity assessment for the SEEU was performed.

10.0 ECOLOGICAL RISK CHARACTERIZATION

Risk characterization includes risk estimation and risk description. Details of these components are described in the CRA Methodology and Appendix A, Volume 2 of the RI/FS Report. Predicted risks should be viewed in terms of the potential for the assumptions used in the risk characterization to occur in nature, the uncertainties associated with the assumptions, and in the potential for effects on the population of receptors that could inhabit the SEEU. Because no ECOPCs were identified for either surface or subsurface soils in the SEEU, no risk characterization is necessary. The ECOPC identification process constitutes a screening level risk assessment. Because the process did not identify any ECOPCs, risks to ecological receptors from site-related contaminants are likely to be negligible in the SEEU.

10.1 Chemical Risk Characterization

No ECOPCs were identified for any receptor in either surface or subsurface soil in the SEEU. The ECOPC identification procedure constitutes a screening-level risk assessment. Because the procedure did not identify any ECOPCs, risks to ecological receptors from site-related contaminants are likely to be negligible in the SEEU.

10.2 General Uncertainty Analysis

Quantitative evaluation of ecological risks is limited by uncertainties regarding the assumptions used to predict risk and the data available for quantifying risk. These limitations are usually addressed by making estimates based on the data available or by making assumptions based on professional judgment when data are limited. Because of these assumptions and estimates, the results of the risk calculations themselves are uncertain, and it is important for risk managers and the public to view the results of the risk assessment with this in mind. A full discussion of categories of general uncertainty that are not specific to the SEEU is presented in Appendix A, Volume 2 of the RI/FS Report. The following sections are potential sources of general uncertainty that are specific to the SEEU ERA.

10.2.1 Uncertainties Associated With Data Adequacy and Quality

Sections 1.2 and 1.3 summarize the general data adequacy and data quality for the SEEU, respectively. A more detailed discussion is presented in Attachment 2 and Appendix A, Volume 2 of the RI/FS Report. The data adequacy assessment indicates that the data are adequate for the CRA. Data of sufficient quality for ERA purposes were collected in surface and subsurface soils.

10.2.2 Uncertainties Associated with the Lack of Toxicity Data for Ecological Contaminant of Interest Detected at the Southwest Buffer Zone Area Exposure Unit

Several ECOIs detected in the SEEU do not have adequate toxicity data for the derivation of ESLs (CRA Methodology). These ECOIs are listed in Tables 7.1 and 7.9 with a “UT” designation. Appendix B of the CRA Methodology outlines a detailed search process that was intended to provide high-quality toxicological information for a large portion of the chemicals detected at RFETS. Although the toxicity is uncertain for those ECOIs that do not have ESLs calculated due to a lack of identified toxicity data, the overall effect on the risk assessment is small because the primary chemicals historically used at RFETS have adequate toxicity data for use in the CRA. Therefore, while the potential for risk from these ECOPCs is uncertain and will tend to underestimate the overall risk calculated, the magnitude of underestimation is likely to be low.

10.2.3 Uncertainties Associated With Eliminating Ecological Contaminants of Interest Based on Professional Judgment

Several analytes in surface soil and subsurface soil were eliminated as ECOIs based on professional judgment. The professional judgment evaluation is intended to identify those ECOIs that have a limited potential for contamination in the SEEU. One historical IHSS exists within the SEEU: Roadway Spraying (PAC 000-501) (Table 1.1 and Figure 1.2). PAC 000-501 was proposed for NFA in 1991 and the NFA was approved in 2002 (EPA 2002) as documented in the 2002 HRR Update (DOE 2002). The weight-of-evidence approach indicates that the concentrations of these ECOIs are most likely due to natural variation. The magnitude of underestimation of risk due to the professional judgment evaluation is unknown, but the ECOIs eliminated from further consideration are not considered related to site-activities in the SEEU and have very low potential to be transported from historical sources to the SEEU.

10.2.4 Summary of Significant Sources of Uncertainty

The preceding discussion outlined the significant sources of uncertainty in the CRA process for assessing ecological risk. While some of the sources of uncertainty discussed tend to either underestimate risk or overestimate risk, many result in an unknown effect on the potential risks. However, the CRA process was designed to be of a conservative nature, which should be taken into consideration when reviewing the conclusions of the risk assessment.

11.0 SUMMARY AND CONCLUSIONS

A summary of the results of this CRA for human health and ecological receptors in the SEEU is presented below.

11.1 Human Health

The COC screening analyses compared MDCs and UCLs of chemicals and radionuclides in SEEU media to PRGs for the WRW receptor. Inorganic and radionuclide analytes with UCLs greater than the PRGs were statistically compared to the background concentration data set. Inorganic and radionuclide analytes that were statistically greater than background at the 0.1 significance level, and organics with UCL concentrations greater than the PRG, were carried forward to professional judgment evaluation. Based on the COC selection process, no COCs were selected for surface soil/surface sediment and subsurface soil/subsurface sediment in the SEEU, and a risk characterization was not performed for the SEEU.

11.2 Ecological Risk

No ECOPCs were identified in surface soil (non-PMJM receptors) or subsurface soil (burrowing receptors). All ECOIs were eliminated from further consideration as ECOPCs based on comparisons of MDCs to NOAEL ESLs, background comparisons, tESL comparisons (non-PMJM receptors only), or professional judgment evaluations. Therefore, potential risks to ecological receptors in the SEEU are likely to be negligible.

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TABLES

Table 1.1
SEEU IHSSs

| IHSS | OU | PAC | Title | Description | Disposition |
|------|----|---------|---------------------|--|----------------|
| -- | BZ | 000-501 | Roadway Spraying | Roadways in the BZ OU were sprayed with waste oils for dust suppression; reverse osmosis brine solutions and footing drain water were also applied. ^a | NFA - 2005 HRR |

^a PAC 000-501 was one of 79 IHSS/PACs proposed for NFA by the NFA Working Group in 1991. The NFA was approved in 2002. (EPA et al. 2002).

Table 1.2
Number of Samples in Each Medium by Analyte Suite

| Analyte Suite | Surface Soil/Surface Sediment ^a | Subsurface Soil/Subsurface Sediment ^a | Surface Soil ^b | Subsurface Soil ^b |
|---------------|--|--|---------------------------|------------------------------|
| Inorganic | 22 | 7 | 19 | 6 |
| Organic | 1 | 7 | 1 | 7 |
| Radionuclide | 55 | 9 | 52 | 8 |

^a Used in the HHRA

^b Used in the ERA

Note: The total number of results (samples) in Tables 1.3 through 1.6 may differ from the total number of samples presented in Table 1.2 because not all analyses are necessarily performed for each sample.

Table 1.3
Summary of Detected Analytes in SEEU Surface Soil/Surface Sediment

| Analyte | Range of Reported Detection Limits | Total Number of Results | Detection Frequency (%) | Minimum Detected Concentration | Maximum Detected Concentration | Arithmetic Mean Concentration | Standard Deviation |
|------------------------------|------------------------------------|-------------------------|-------------------------|--------------------------------|--------------------------------|-------------------------------|--------------------|
| Inorganics (mg/kg) | | | | | | | |
| Aluminum | 3.9 - 40 | 22 | 100 | 5,860 | 26,000 | 15,613 | 5,417 |
| Antimony ^b | 0.29 - 12 | 21 | 33.3 | 0.350 | 0.590 | 1.27 | 2.23 |
| Arsenic | 0.69 - 2 | 22 | 100 | 2.50 | 23 | 7.40 | 4.15 |
| Barium | 0.18 - 40 | 22 | 100 | 57 | 240 | 142 | 46.2 |
| Beryllium | 0.022 - 1 | 22 | 86.4 | 0.520 | 1.50 | 0.874 | 0.314 |
| Boron | 0.56 - 3 | 17 | 100 | 3.70 | 19 | 6.93 | 3.52 |
| Cadmium | 0.066 - 1 | 22 | 72.7 | 0.120 | 1 | 0.368 | 0.206 |
| Calcium | 3.5 - 1000 | 22 | 100 | 1,760 | 55,000 | 9,195 | 11,667 |
| Cesium ^b | 200 | 3 | 33.3 | 14.5 | 14.5 | 7.27 | 6.27 |
| Chromium | 0.071 - 2 | 22 | 100 | 7.30 | 27 | 17.1 | 5.66 |
| Cobalt | 0.14 - 10 | 22 | 100 | 2.80 | 10.4 | 7.69 | 1.88 |
| Copper | 0.047 - 5 | 22 | 100 | 7.80 | 27 | 15.7 | 4.71 |
| Iron | 1.4 - 20 | 22 | 100 | 7,970 | 52,000 | 22,058 | 11,195 |
| Lead | 0.28 - 1 | 22 | 100 | 4.80 | 37 | 23.1 | 7.01 |
| Lithium | 0.066 - 20 | 19 | 94.7 | 5.20 | 23 | 13.6 | 5.62 |
| Magnesium | 2 - 1000 | 22 | 100 | 1,360 | 7,100 | 3,236 | 1,316 |
| Manganese | 0.18 - 3 | 22 | 100 | 55 | 1,300 | 386 | 237 |
| Mercury | 0.0056 - 0.1 | 19 | 36.8 | 0.0140 | 0.0290 | 0.0155 | 0.0117 |
| Molybdenum | 0.23 - 40 | 21 | 81.0 | 0.260 | 1.90 | 1.08 | 0.591 |
| Nickel | 0.2 - 8 | 22 | 100 | 9.30 | 35 | 16.2 | 5.84 |
| Potassium | 22 - 1000 | 22 | 100 | 1,200 | 5,200 | 3,066 | 873 |
| Selenium | 0.82 - 1.4 | 22 | 13.6 | 0.270 | 1.70 | 0.448 | 0.307 |
| Silica | 1.8 - 5.1 | 17 | 100 | 580 | 2,900 | 1,007 | 555 |
| Silver | 0.08 - 2 | 21 | 33.3 | 0.120 | 0.390 | 0.250 | 0.219 |
| Sodium | 100 - 1000 | 22 | 22.7 | 54.8 | 510 | 79.0 | 98.2 |
| Strontium | 0.06 - 40 | 21 | 100 | 12.1 | 290 | 56.3 | 56.9 |
| Thallium | 0.37 - 2 | 22 | 9.09 | 2.30 | 2.60 | 0.575 | 0.632 |
| Titanium | 0.089 - 0.44 | 17 | 100 | 64 | 260 | 144 | 53.1 |
| Uranium | 1.3 - 2.1 | 17 | 23.5 | 1.60 | 2.80 | 1.09 | 0.640 |
| Vanadium | 0.41 - 10 | 22 | 100 | 22 | 140 | 50.0 | 25.7 |
| Zinc | 0.47 - 4 | 22 | 100 | 18 | 81 | 54.3 | 15.7 |
| Radionuclides (pCi/g) | | | | | | | |
| Americium-241 | 0 - 0.206 | 46 | N/A | -0.00600 | 0.381 | 0.0466 | 0.0624 |
| Cesium-137 | 0.0510 | 1 | N/A | 0.661 | 0.661 | 0.661 | N/A |
| Gross Beta | 1 - 20 | 6 | N/A | 18 | 41 | 26.8 | 7.79 |
| Plutonium-239/240 | 0 - 0.219 | 54 | N/A | 0.00205 | 4.60 | 0.251 | 0.628 |
| Radium-226 | 0.740 | 1 | N/A | 2.02 | 2.02 | 2.02 | N/A |
| Radium-228 | 0.189 | 1 | N/A | 1.59 | 1.59 | 1.59 | N/A |
| Uranium-233/234 | 0 - 0.588 | 37 | N/A | 0.119 | 1.52 | 0.762 | 0.445 |
| Uranium-235 | 0 - 0.518 | 37 | N/A | -0.0564 | 0.344 | 0.0511 | 0.0725 |
| Uranium-238 | 0 - 0.459 | 37 | N/A | 0.162 | 1.81 | 0.820 | 0.433 |
| Cesium-134 | 0.0492 | 1 | N/A | -0.265 | -0.265 | -0.265 | N/A |
| Gross Alpha | 2.92 - 30 | 6 | N/A | 8.47 | 43 | 17.0 | 13.3 |
| Strontium-89/90 | 0.0656 - 0.4319 | 3 | N/A | 0.110 | 0.171 | 0.140 | 0.0304 |

^a For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

^b All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

^c All radionuclide values are considered detects.

N/A = Not applicable.

Note: Organics were not detected.

Table 1.4
Summary of Detected Analytes in Subsurface Soil/Subsurface Sediment

| Analyte | Range of Reported Detection Limits | Total Number of Results | Detection Frequency (%) | Minimum Detected Concentration | Maximum Detected Concentration | Arithmetic Mean Concentration ^a | Standard Deviation ^a |
|------------------------------|------------------------------------|-------------------------|-------------------------|--------------------------------|--------------------------------|--|---------------------------------|
| Inorganics (mg/kg) | | | | | | | |
| Aluminum | 4.1 - 40 | 7 | 100 | 463 | 25,000 | 10,278 | 8,548 |
| Arsenic | 0.29 - 2.3 | 7 | 100 | 2.70 | 19.1 | 7.87 | 5.27 |
| Barium | 0.18 - 40 | 7 | 100 | 19 | 190 | 108 | 77.7 |
| Beryllium | 0.031 - 1 | 7 | 71.4 | 0.330 | 1.20 | 0.546 | 0.434 |
| Boron | 1.80 | 1 | 100 | 11 | 11 | 11 | N/A |
| Cadmium | 0.07 - 1 | 6 | 33.3 | 0.450 | 0.850 | 0.440 | 0.209 |
| Calcium | 1.3 - 1000 | 7 | 100 | 1,350 | 20,000 | 11,787 | 6,877 |
| Cesium ^b | 81.6 - 200 | 6 | 33.3 | 1.80 | 2.70 | 33.8 | 25.1 |
| Chromium | 0.074 - 2 | 7 | 100 | 1.70 | 26 | 11.4 | 9.06 |
| Cobalt | 0.14 - 10 | 7 | 100 | 0.890 | 10.8 | 5.78 | 3.82 |
| Copper | 0.091 - 5 | 7 | 85.7 | 2.80 | 22 | 11.1 | 8.81 |
| Iron | 0.52 - 20 | 7 | 100 | 4,020 | 34,600 | 14,266 | 11,224 |
| Lead | 0.19 - 4.9 | 7 | 100 | 4.10 | 22 | 10.2 | 6.69 |
| Lithium | 0.28 - 20 | 7 | 85.7 | 2.10 | 21 | 9.33 | 8.06 |
| Magnesium | 3.6 - 1000 | 7 | 100 | 135 | 8,920 | 3,439 | 3,124 |
| Manganese | 0.13 - 3 | 7 | 100 | 28.1 | 699 | 226 | 225 |
| Mercury | 0.0067 - 0.11 | 7 | 14.3 | 0.0230 | 0.0230 | 0.0384 | 0.0116 |
| Molybdenum | 0.24 - 40 | 7 | 42.9 | 0.550 | 10.6 | 2.17 | 3.72 |
| Nickel | 0.24 - 8 | 7 | 85.7 | 3.60 | 29.2 | 14.0 | 9.96 |
| Potassium | 44 - 1000 | 7 | 85.7 | 346 | 3,900 | 1,517 | 1,348 |
| Selenium | 0.31 - 1 | 7 | 57.1 | 0.430 | 2.40 | 0.911 | 0.901 |
| Silica | 1.80 | 1 | 100 | 1,900 | 1,900 | 1,900 | N/A |
| Silicon ^b | 0 | 2 | 100 | 85.1 | 147 | 116 | 43.8 |
| Sodium | 2.2 - 1000 | 7 | 85.7 | 70.8 | 2,700 | 585 | 973 |
| Strontium | 0.11 - 40 | 7 | 100 | 18.7 | 172 | 74.8 | 61.0 |
| Thallium | 0.26 - 2 | 7 | 14.3 | 1.20 | 1.20 | 0.294 | 0.401 |
| Titanium | 0.270 | 1 | 100 | 260 | 260 | 260 | N/A |
| Vanadium | 0.36 - 10 | 7 | 85.7 | 5.90 | 60 | 30.8 | 23.0 |
| Zinc | 0.39 - 4 | 7 | 100 | 9 | 76.2 | 37.6 | 30.4 |
| Organics (ug/kg) | | | | | | | |
| 1,1,1-Trichloroethane | 5 - 6 | 5 | 20 | 44 | 44 | 11.2 | 18.3 |
| bis(2-Ethylhexyl)phthalate | 330 | 3 | 66.7 | 49 | 75 | 101 | 69.4 |
| Styrene | 5 - 6 | 5 | 20 | 2 | 2 | 2.80 | 0.447 |
| Toluene | 5 - 6 | 5 | 40 | 9 | 19 | 7.40 | 6.99 |
| Xylene | 5 - 6 | 5 | 20 | 3 | 3 | 3 | 0 |
| Radionuclides (pCi/g) | | | | | | | |
| Americium-241 | 0.00504 - 0.123 | 5 | N/A | 0.00129 | 0.0504 | 0.0154 | 0.0201 |
| Cesium-134 | 0.0142 - 0.0602 | 4 | N/A | -0.0766 | -0.00366 | -0.0334 | 0.0351 |
| Cesium-137 | 0.0134 - 0.061 | 4 | N/A | 0.00242 | 0.160 | 0.0699 | 0.0766 |

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Table 1.4
Summary of Detected Analytes in Subsurface Soil/Subsurface Sediment

| Analyte | Range of Reported Detection Limits | Total Number of Results | Detection Frequency (%) | Minimum Detected Concentration | Maximum Detected Concentration | Arithmetic Mean Concentration ^a | Standard Deviation ^a |
|-------------------|------------------------------------|-------------------------|-------------------------|--------------------------------|--------------------------------|--|---------------------------------|
| Gross Alpha | 0.82 - 3.95 | 8 | N/A | 7 | 20.4 | 12.9 | 4.20 |
| Gross Beta | 1 - 4.7 | 8 | N/A | 13.6 | 30.4 | 21.7 | 5.42 |
| Plutonium-238 | 0.0107 | 1 | N/A | 0 | 0 | 0 | N/A |
| Plutonium-239/240 | 0 - 0.123 | 8 | N/A | 0 | 0.0277 | 0.0125 | 0.0107 |
| Radium-226 | 0.249 - 0.747 | 4 | N/A | -0.367 | 1.78 | 0.585 | 1.09 |
| Radium-228 | 0.044 - 0.216 | 4 | N/A | 0.191 | 2.01 | 0.999 | 0.897 |
| Strontium-89/90 | 0.0596 - 0.399 | 6 | N/A | 0.0155 | 0.240 | 0.0796 | 0.0844 |
| Uranium-233/234 | 0.0285 - 0.284 | 7 | N/A | 1.10 | 1.78 | 1.43 | 0.267 |
| Uranium-235 | 0.0176 - 0.266 | 7 | N/A | 0.0191 | 0.0763 | 0.0439 | 0.0224 |
| Uranium-238 | 0.0132 - 0.146 | 7 | N/A | 1.31 | 1.83 | 1.46 | 0.179 |

^a For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

^b All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

^c All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.5
Summary of Detected Analytes in Surface Soil (Non-PMJM)

| Analyte | Range of Reported Detection Limits | Total Number of Results | Detection Frequency (%) | Minimum Detected Concentration | Maximum Detected Concentration | Arithmetic Mean Concentration | Standard Deviation |
|------------------------------|------------------------------------|-------------------------|-------------------------|--------------------------------|--------------------------------|-------------------------------|--------------------|
| Inorganics (mg/kg) | | | | | | | |
| Aluminum | 3.9 - 40 | 19 | 100 | 5,860 | 25,000 | 15,362 | 4,928 |
| Antimony ^b | 0.29 - 12 | 18 | 38.9 | 0.350 | 0.590 | 1.41 | 2.39 |
| Arsenic | 0.83 - 2 | 19 | 100 | 2.50 | 23 | 7.43 | 4.41 |
| Barium | 0.38 - 40 | 19 | 100 | 57 | 210 | 141 | 41.4 |
| Beryllium | 0.022 - 1 | 19 | 84.2 | 0.530 | 1.50 | 0.853 | 0.303 |
| Boron | 0.56 - 1.1 | 14 | 100 | 3.70 | 8.70 | 5.95 | 1.47 |
| Cadmium | 0.066 - 1 | 19 | 68.4 | 0.120 | 1 | 0.356 | 0.207 |
| Calcium | 3.5 - 1000 | 19 | 100 | 1,760 | 23,000 | 6,731 | 5,808 |
| Cesium ^b | 200 | 3 | 33.3 | 14.5 | 14.5 | 7.27 | 6.27 |
| Chromium | 0.16 - 2 | 19 | 100 | 7.30 | 27 | 17.0 | 5.43 |
| Cobalt | 0.19 - 10 | 19 | 100 | 2.80 | 10.4 | 7.78 | 1.94 |
| Copper | 0.047 - 5 | 19 | 100 | 7.80 | 25 | 15.2 | 3.83 |
| Iron | 1.4 - 20 | 19 | 100 | 7,970 | 52,000 | 21,856 | 11,561 |
| Lead | 0.28 - 1 | 19 | 100 | 4.80 | 37 | 23.9 | 6.63 |
| Lithium | 0.066 - 20 | 16 | 93.8 | 5.20 | 23 | 13.3 | 5.29 |
| Magnesium | 2 - 1000 | 19 | 100 | 1,360 | 5,000 | 3,084 | 1,009 |
| Manganese | 0.18 - 3 | 19 | 100 | 55 | 1,300 | 392 | 247 |
| Mercury ^b | 0.0056 - 0.1 | 16 | 25 | 0.0140 | 0.0210 | 0.0139 | 0.0119 |
| Molybdenum | 0.3 - 40 | 18 | 77.8 | 0.610 | 1.90 | 1.14 | 0.605 |
| Nickel | 0.2 - 8 | 19 | 100 | 9.30 | 35 | 16.3 | 6.03 |
| Potassium | 22 - 1000 | 19 | 100 | 1,430 | 4,000 | 3,066 | 663 |
| Selenium ^b | 0.82 - 1 | 19 | 10.5 | 0.270 | 0.320 | 0.381 | 0.135 |
| Silica ^b | 4.4 - 5.1 | 14 | 100 | 580 | 990 | 817 | 126 |
| Silver | 0.08 - 2 | 18 | 38.9 | 0.120 | 0.390 | 0.281 | 0.222 |
| Sodium | 100 - 1000 | 19 | 21.1 | 54.8 | 137 | 58.4 | 21.1 |
| Strontium | 0.06 - 40 | 18 | 100 | 12.1 | 90 | 43.8 | 20.0 |
| Titanium ^b | 0.089 - 0.1 | 14 | 100 | 83 | 210 | 137 | 39.5 |
| Uranium | 1.4 - 1.7 | 14 | 14.3 | 1.60 | 1.80 | 0.907 | 0.340 |
| Vanadium | 0.48 - 10 | 19 | 100 | 22.5 | 140 | 50.5 | 26.7 |
| Zinc | 0.47 - 4 | 19 | 100 | 18 | 71 | 53.6 | 15.1 |
| Radionuclides (pCi/g) | | | | | | | |
| Americium-241 | 0 - 0.206 | 43 | N/A | -0.00600 | 0.381 | 0.0465 | 0.0644 |
| Cesium-137 | 0.0510 | 1 | N/A | 0.661 | 0.661 | 0.661 | N/A |
| Gross Beta | 1 - 20 | 6 | N/A | 18 | 41 | 26.8 | 7.79 |

Table 1.5
Summary of Detected Analytes in Surface Soil (Non-PMJM)

| Analyte | Range of Reported Detection Limits | Total Number of Results | Detection Frequency (%) | Minimum Detected Concentration | Maximum Detected Concentration | Arithmetic Mean Concentration | Standard Deviation |
|-------------------|------------------------------------|-------------------------|-------------------------|--------------------------------|--------------------------------|-------------------------------|--------------------|
| Cesium-134 | 0.0492 | 1 | N/A | -0.265 | -0.265 | -0.265 | N/A |
| Gross Alpha | 2.92 - 30 | 6 | N/A | 8.47 | 43 | 17.0 | 13.3 |
| Plutonium-239/240 | 0 - 0.195 | 51 | N/A | 0.00520 | 4.60 | 0.259 | 0.645 |
| Radium-226 | 0.740 | 1 | N/A | 2.02 | 2.02 | 2.02 | N/A |
| Radium-228 | 0.189 | 1 | N/A | 1.59 | 1.59 | 1.59 | N/A |
| Strontium-89/90 | 0.0656 - 0.4319 | 3 | N/A | 0.110 | 0.171 | 0.140 | 0.0304 |
| Uranium-233/234 | 0 - 0.588 | 34 | N/A | 0.119 | 1.47 | 0.714 | 0.425 |
| Uranium-235 | 0 - 0.518 | 34 | N/A | -0.0564 | 0.344 | 0.0464 | 0.0734 |
| Uranium-238 | 0 - 0.459 | 34 | N/A | 0.162 | 1.50 | 0.784 | 0.415 |

^a For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

^b All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

^c All radionuclide values are considered detects.

N/A = Not applicable.

Note: Organics were not detected.

Table 1.6
Summary of Detected Analytes in Subsurface Soil

| Analyte | Range of Reported Detection Limits | Total Number of Results | Detection Frequency (%) | Minimum Detected Concentration | Maximum Detected Concentration | Arithmetic Mean Concentration | Standard Deviation |
|------------------------------|------------------------------------|-------------------------|-------------------------|--------------------------------|--------------------------------|-------------------------------|--------------------|
| Inorganics (mg/kg) | | | | | | | |
| Aluminum | 4.1 - 40 | 6 | 100 | 463 | 15,300 | 7,824 | 6,091 |
| Arsenic | 0.29 - 2.3 | 6 | 100 | 2.70 | 19.1 | 8.10 | 5.74 |
| Barium | 0.23 - 40 | 6 | 100 | 19 | 185 | 94.1 | 75.3 |
| Beryllium | 0.23 - 1 | 6 | 66.7 | 0.330 | 1.10 | 0.438 | 0.356 |
| Cadmium ^b | 0.54 - 1 | 5 | 20 | 0.850 | 0.850 | 0.438 | 0.234 |
| Calcium | 1.3 - 1000 | 6 | 100 | 1,350 | 20,000 | 10,918 | 7,101 |
| Cesium ^b | 81.6 - 200 | 6 | 33.3 | 1.80 | 2.70 | 33.8 | 25.1 |
| Chromium | 0.59 - 2 | 6 | 100 | 1.70 | 17.5 | 8.95 | 6.97 |
| Cobalt | 0.41 - 10 | 6 | 100 | 0.890 | 10.8 | 5.35 | 3.99 |
| Copper | 0.24 - 5 | 6 | 83.3 | 2.80 | 21.2 | 9.30 | 8.09 |
| Iron | 0.52 - 20 | 6 | 100 | 4,020 | 34,600 | 12,810 | 11,548 |
| Lead | 0.19 - 4.9 | 6 | 100 | 4.10 | 15.7 | 8.18 | 4.58 |
| Lithium | 0.28 - 20 | 6 | 83.3 | 2.10 | 16.1 | 7.38 | 6.80 |
| Magnesium | 3.6 - 1000 | 6 | 100 | 135 | 8,920 | 3,162 | 3,326 |
| Manganese | 0.13 - 3 | 6 | 100 | 28.1 | 699 | 222 | 247 |
| Molybdenum | 0.77 - 40 | 6 | 33.3 | 0.930 | 10.6 | 2.44 | 4.00 |
| Nickel | 1.9 - 8 | 6 | 83.3 | 3.60 | 29.2 | 12.8 | 10.4 |
| Potassium | 77.8 - 1000 | 6 | 83.3 | 346 | 2,610 | 1,120 | 925 |
| Selenium | 0.31 - 1 | 6 | 66.7 | 0.430 | 2.40 | 0.990 | 0.960 |
| Silicon ^b | 0 | 2 | 100 | 85.1 | 147 | 116 | 43.8 |
| Sodium | 2.2 - 1000 | 6 | 100 | 70.8 | 2,700 | 672 | 1,035 |
| Strontium | 0.83 - 40 | 6 | 100 | 18.7 | 172 | 72.8 | 66.5 |
| Vanadium | 0.36 - 10 | 6 | 83.3 | 5.90 | 58.1 | 26.0 | 20.9 |
| Zinc | 0.39 - 4 | 6 | 100 | 9 | 76.2 | 31.5 | 28.2 |
| Organics (ug/kg) | | | | | | | |
| 1,1,1-Trichloroethane | 5 - 6 | 5 | 20 | 44 | 44 | 11.2 | 18.3 |
| bis(2-Ethylhexyl)phthalate | 330 | 3 | 66.7 | 49 | 75 | 101 | 69.4 |
| Styrene | 5 - 6 | 5 | 20 | 2 | 2 | 2.80 | 0.447 |
| Toluene | 5 - 6 | 5 | 40 | 9 | 19 | 7.40 | 6.99 |
| Xylene | 5 - 6 | 5 | 20 | 3 | 3 | 3 | 0 |
| Radionuclides (pCi/g) | | | | | | | |
| Americium-241 | 0.00504 - 0.00831 | 4 | N/A | 0.00129 | 0.0136 | 0.00666 | 0.00514 |
| Cesium-134 | 0.0142 - 0.0602 | 4 | N/A | -0.0766 | -0.00366 | -0.0334 | 0.0351 |
| Cesium-137 | 0.0134 - 0.061 | 4 | N/A | 0.00242 | 0.160 | 0.0699 | 0.0766 |
| Gross Alpha | 0.82 - 3.95 | 8 | N/A | 7 | 20.4 | 12.9 | 4.20 |
| Gross Beta | 1 - 4.7 | 8 | N/A | 13.6 | 30.4 | 21.7 | 5.42 |
| Plutonium-238 | 0.0107 | 1 | N/A | 0 | 0 | 0 | N/A |
| Plutonium-239/240 | 0 - 0.0152 | 7 | N/A | 0 | 0.0277 | 0.0117 | 0.0113 |
| Radium-226 | 0.249 - 0.747 | 4 | N/A | -0.367 | 1.78 | 0.585 | 1.09 |
| Radium-228 | 0.044 - 0.216 | 4 | N/A | 0.191 | 2.01 | 0.999 | 0.897 |
| Strontium-89/90 | 0.0596 - 0.399 | 6 | N/A | 0.0155 | 0.240 | 0.0796 | 0.0844 |
| Uranium-233/234 | 0.0285 - 0.0905 | 6 | N/A | 1.23 | 1.78 | 1.49 | 0.245 |
| Uranium-235 | 0.0176 - 0.0555 | 6 | N/A | 0.0191 | 0.0763 | 0.0454 | 0.0241 |
| Uranium-238 | 0.0132 - 0.0555 | 6 | N/A | 1.33 | 1.83 | 1.49 | 0.181 |

^a For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

^b All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

^c All radionuclide values are considered detects.

N/A = Not applicable.

Table 2.1
Essential Nutrient Screen for Surface Soil/Surface Sediment

| Analyte | MDC (mg/kg) | Estimated Maximum Daily Intake (mg/day) | RDA/RDI/AI ^b (mg/day) | UL ^b (mg/day) | Retain for PRG Screen? |
|-----------|-------------|---|-------------------------------------|--------------------------|---------------------------|
| Calcium | 55,000 | 5.50 | 500-1,200 | 2,500 | No |
| Magnesium | 7,100 | 0.710 | 80-420 | 65-110 | No |
| Potassium | 5,200 | 0.520 | 2,000-3,500 | N/A | No |
| Sodium | 510 | 0.0510 | 500-2,400 | N/A | No |

^a Based on the MDC and a 100 mg/day soil ingestion rate for a WRW.

^b RDA/RDI/AI/UL taken from NAS 2000 and 2002.

N/A = Not available.

Table 2.2
PRG Screen for Surface Soil/Surface Sediment

| Analyte | PRG | MDC | MDC Exceeds PRG? | UCL | UCL Exceeds PRG? | Retain for Detection Frequency Screen? |
|------------------------------|---------|--------|------------------|--------|------------------|--|
| Inorganics (mg/kg) | | | | | | |
| Aluminum | 24,774 | 26,000 | Yes | 17,600 | No | No |
| Antimony | 44.4 | 0.590 | No | -- | -- | No |
| Arsenic | 2.41 | 23 | Yes | 8.90 | Yes | Yes |
| Barium | 2,872 | 240 | No | -- | -- | No |
| Beryllium | 100 | 1.50 | No | -- | -- | No |
| Boron | 9,477 | 19 | No | -- | -- | No |
| Cadmium | 91.4 | 1 | No | -- | -- | No |
| Calcium | N/A | 55,000 | No | -- | -- | UT |
| Cesium | N/A | 14.5 | No | -- | -- | UT |
| Chromium ^c | 28.4 | 27 | No | -- | -- | No |
| Cobalt | 122 | 10.4 | No | -- | -- | No |
| Copper | 4,443 | 27 | No | -- | -- | No |
| Iron | 33,326 | 52,000 | Yes | 26,477 | No | No |
| Lead | 1,000 | 37 | No | -- | -- | No |
| Lithium | 2,222 | 23 | No | -- | -- | No |
| Magnesium | N/A | 7,100 | No | -- | -- | UT |
| Manganese | 419 | 1,300 | Yes | 607 | Yes | Yes |
| Mercury | 32.9 | 0.0290 | No | -- | -- | No |
| Molybdenum | 555 | 1.90 | No | -- | -- | No |
| Nickel | 2,222 | 35 | No | -- | -- | No |
| Potassium | N/A | 5,200 | No | -- | -- | UT |
| Selenium | 555 | 1.70 | No | -- | -- | No |
| Silica | N/A | 2,900 | No | -- | -- | UT |
| Silver | 555 | 0.390 | No | -- | -- | No |
| Sodium | N/A | 510 | No | -- | -- | UT |
| Strontium | 66,652 | 290 | No | -- | -- | No |
| Thallium | 7.78 | 2.60 | No | -- | -- | No |
| Titanium | 169,568 | 260 | No | -- | -- | No |
| Uranium | 333 | 2.80 | No | -- | -- | No |
| Vanadium | 111 | 140 | No | 59.5 | No | No |
| Zinc | 33,326 | 81 | No | -- | -- | No |
| Radionuclides (pCi/g) | | | | | | |
| Americium-241 | 7.69 | 0.381 | No | -- | -- | No |
| Cesium-134 | 0.0800 | -0.265 | No | -- | -- | No |
| Cesium-137 | 0.221 | 0.661 | Yes | N/A | Yes | Yes |
| Gross alpha | N/A | 43 | No | -- | -- | UT |
| Gross beta | N/A | 41 | No | -- | -- | UT |

Table 2.2
PRG Screen for Surface Soil/Surface Sediment

| Analyte | PRG ^a | MDC | MDC Exceeds PRG? | UCL ^b | UCL Exceeds PRG? | Retain for Detection Frequency Screen? |
|-------------------|------------------|-------------|------------------|------------------|------------------|--|
| Plutonium-239/240 | 9.80 | 4.60 | No | -- | -- | No |
| Radium-226 | 2.69 | 2.02 | No | -- | -- | No |
| Radium-228 | 0.111 | 1.59 | Yes | N/A | Yes | Yes |
| Strontium-89/90 | 13.2 | 0.171 | No | -- | -- | No |
| Uranium-233/234 | 25.3 | 1.52 | No | -- | -- | No |
| Uranium-235 | 1.05 | 0.344 | No | -- | -- | No |
| Uranium-238 | 29.3 | 1.81 | No | -- | -- | No |

^a The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.

^b UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

^c The PRG for chromium (VI) is used in the PRG screen because it is more conservative than the PRG for chromium (III).

N/A = Not available.

UT = Uncertain toxicity; no PRG available (assessed in Section 6.0)

-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.

Bold = Analyte retained for further consideration in the next COC selection step.

Table 2.3

Statistical Distributions and Comparison to Background for the SEEU^a

| Analyte | Statistical Distribution Testing Results | | | | | | Background Comparison | | |
|-------------------------------------|--|------------------------------------|-------------|---------------|------------------------------------|-------------|-----------------------|----------|-----------------|
| | Background | | | SEEU | | | Test | 1 - p | Retain as PCOC? |
| | Total Samples | Distribution Recommended by ProUCL | Detects (%) | Total Samples | Distribution Recommended by ProUCL | Detects (%) | | | |
| Surface Soil/Surface Sediment | | | | | | | | | |
| Arsenic | 73 | GAMMA | 91.8 | 22 | GAMMA | 100 | WRS | 1.28E-06 | Yes |
| Manganese | 73 | GAMMA | 100 | 22 | NONPARAMETRIC | 100 | WRS | 5.28E-05 | Yes |
| Cesium-137 | 105 | NONPARAMETRIC | 100 | 1 | N/A | N/A | WRS | N/A | Yes |
| Radium-228 | 40 | GAMMA | 100 | 1 | N/A | N/A | WRS | N/A | Yes |
| Subsurface Soil/Subsurface Sediment | | | | | | | | | |
| Radium-228 | 31 | GAMMA | 100 | 4 | NORMAL | N/A | WRS | 0.767 | No |

^a EU data used for background comparisons do not include data from background locations.

WRS = Wilcoxon Rank Sum Test.

N/A = Not available or not applicable.

Bold = PCOCs retained for further consideration in the next COC selection step.

Table 2.4
Essential Nutrient Screen for Subsurface Soil/Subsurface Sediment

| Analyte | MDC (mg/kg) | Estimated Maximum Daily Intake ^a (mg/day) | RDA/RDI/AI ^b (mg/day) | UL ^b (mg/day) | Retain for PRG Screen? |
|-----------|----------------|---|-------------------------------------|--------------------------|---------------------------|
| Calcium | 20,000 | 2 | 500-1,200 | 2,500 | No |
| Magnesium | 8,920 | 0.892 | 80-420 | 65-110 | No |
| Potassium | 3,900 | 0.390 | 2,000-3,500 | N/A | No |
| Sodium | 2,700 | 0.270 | 500-2,400 | N/A | No |

^a Based on the MDC and a 100 mg/day soil ingestion rate for a WRW.

^b RDA/RDI/AI/UL taken from NAS 2000 and 2002.

N/A = Not available.

Table 2.5
PRG Screen for Subsurface Soil/Subsurface Sediment

| Analyte | PRG ^a | MDC | MDC Greater Than PRG? | UCL | UCL Greater Than PRG? | Retain for Detection Frequency Screen? |
|------------------------------|------------------|-------------|-----------------------|-------------|-----------------------|--|
| Inorganics (mg/kg) | | | | | | |
| Aluminum | 284,902 | 25,000 | No | -- | -- | No |
| Arsenic | 27.7 | 19.1 | No | -- | -- | No |
| Barium | 33,033 | 190 | No | -- | -- | No |
| Beryllium | 1,151 | 1.20 | No | -- | -- | No |
| Boron | 108,980 | 11 | No | -- | -- | No |
| Cadmium | 1,051 | 0.850 | No | -- | -- | No |
| Calcium | N/A | 20,000 | UT | -- | -- | UT |
| Cesium | N/A | 2.70 | UT | -- | -- | UT |
| Chromium ^c | 327 | 26 | No | -- | -- | No |
| Cobalt | 1,401 | 10.8 | No | -- | -- | No |
| Copper | 51,100 | 22 | No | -- | -- | No |
| Iron | 383,250 | 34,600 | No | -- | -- | No |
| Lead | 1,000 | 22 | No | -- | -- | No |
| Lithium | 25,550 | 21 | No | -- | -- | No |
| Magnesium | N/A | 8,920 | UT | -- | -- | UT |
| Manganese | 4,815 | 699 | No | -- | -- | No |
| Mercury | 379 | 0.0230 | No | -- | -- | No |
| Molybdenum | 6,388 | 10.6 | No | -- | -- | No |
| Nickel | 25,550 | 29.2 | No | -- | -- | No |
| Potassium | N/A | 3,900 | UT | -- | -- | UT |
| Selenium | 6,388 | 2.40 | No | -- | -- | No |
| Silica | N/A | 1,900 | UT | -- | -- | UT |
| Silicon | N/A | 147 | UT | -- | -- | UT |
| Sodium | N/A | 2,700 | UT | -- | -- | UT |
| Strontium | 766,500 | 172 | No | -- | -- | No |
| Thallium | 89.4 | 1.20 | No | -- | -- | No |
| Titanium | 1.95E+06 | 260 | No | -- | -- | No |
| Vanadium | 1,278 | 60 | No | -- | -- | No |
| Zinc | 383,250 | 76.2 | No | -- | -- | No |
| Organics (ug/kg) | | | | | | |
| 1,1,1-Trichloroethane | 1.06E+08 | 44 | No | -- | -- | No |
| bis(2-Ethylhexyl)phthalate | 2.46E+06 | 75 | No | -- | -- | No |
| Styrene | 1.59E+08 | 2 | No | -- | -- | No |
| Toluene | 3.56E+07 | 19 | No | -- | -- | No |
| Xylene ^d | 1.22E+07 | 3 | No | -- | -- | No |
| Radionuclides (pCi/g) | | | | | | |
| Americium-241 | 88.4 | 0.0504 | No | -- | -- | No |
| Cesium-134 | 0.910 | -0.00366 | No | -- | -- | No |
| Cesium-137 | 2.54 | 0.160 | No | -- | -- | No |
| Gross Alpha | N/A | 20.4 | UT | -- | -- | UT |
| Gross Beta | N/A | 30.4 | UT | -- | -- | UT |
| Plutonium-238 | 68.7 | 0 | No | -- | -- | No |
| Plutonium-239/240 | 112 | 0.0277 | No | -- | -- | No |
| Radium-226 | 31 | 1.78 | No | -- | -- | No |
| Radium-228 | 1.28 | 2.01 | Yes | 2.05 | Yes | Yes |
| Strontium-89/90 | 152 | 0.240 | No | -- | -- | No |
| Uranium-233/234 | 291 | 1.78 | No | -- | -- | No |
| Uranium-235 | 12.1 | 0.0763 | No | -- | -- | No |
| Uranium-238 | 337 | 1.83 | No | -- | -- | No |

^a The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.

^b UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

^c The PRG for chromium (VI) is used in the PRG screen because it is more conservative than the PRG for chromium (III).

^d The PRG for total xylene is used.

N/A = Not available.

UT = Uncertain toxicity; no PRG available (assessed in Section 6.0).

-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.

Bold = Analyte retained for further consideration in the next COC selection step.

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Table 2.6
Summary of the COC Selection Process

| Analyte | MDC Exceeds PRG? | UCL Exceeds PRG? | Detection Frequency > 5%? | Exceeds 30X the PRG? | Exceeds Background? | Professional Judgment Retain? | Retain as COC? |
|--|------------------|------------------|---------------------------|----------------------|---------------------|-------------------------------|----------------|
| Surface Soil/Surface Sediment | | | | | | | |
| Aluminum | Yes | No | -- | -- | -- | -- | -- |
| Arsenic | Yes | Yes | Yes | N/A | Yes | No | No |
| Iron | Yes | No | -- | -- | -- | -- | -- |
| Manganese | Yes | Yes | Yes | N/A | Yes | No | No |
| Vanadium | Yes | No | -- | -- | -- | -- | -- |
| Cesium-137 | Yes | Yes | N/A | N/A | N/A ^b | No | No |
| Radium-228 | Yes | Yes | N/A | N/A | N/A ^b | No | No |
| Subsurface Soil/Subsurface Sediment | | | | | | | |
| Radium-228 | Yes | Yes | N/A | N/A | No | -- | No |

^a All radionuclide values are considered detects.

^b The background analysis was not conducted, because only one sample was collected for this analyte at the SEEU.

N/A - Not applicable.

-- = Screen not performed because analyte was eliminated from further consideration in a previous COC selection step.

Table 6.1
Summary of Detected PCOCs Without PRGs^a

| Analyte | Surface Soil/Surface Sediment | Subsurface Soil/Subsurface Sediment |
|----------------------|-------------------------------|-------------------------------------|
| Inorganics | | |
| Cesium | X ^b | X ^b |
| Silica | X | X |
| Silicon | N/A | X ^b |
| Radionuclides | | |
| Gross Alpha | X | X |
| Gross Beta | X | X |

^a Does not include essential nutrients. Essential nutrients without PRGs were evaluated by comparing estimated intakes to recommended intakes.

^b All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

N/A = Not Applicable. Analyte not detected or not analyzed.

X = PRG is unavailable.

Table 7.1

^a Radionuclide ESLs are not receptor-specific. They are considered protective of all terrestrial ecological species.
^b ESLs for chromium were developed based on available toxicity data and are based on Chromium III (birds) and Chromium VI (plants, invertebrates, and mammals).
 N/A = No ESL available for the ECOL/receptor pair.
 UT = Uncertain toxicity; no ESL available (assessed in Section 10).
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.2
Summary of Non-PMJM NOAEL ESL Screening Results for Surface Soil in the SEEU

| Analyte | Terrestrial Plant Exceedance? | Terrestrial Invertebrate Exceedance? | Terrestrial Vertebrate Exceedance? |
|------------------------------|-------------------------------|--------------------------------------|------------------------------------|
| Inorganics (mg/kg) | | | |
| Aluminum | Yes | UT | UT |
| Antimony | No | No | No |
| Arsenic | Yes | No | Yes |
| Barium | No | No | Yes |
| Beryllium | No | No | No |
| Boron | Yes | UT | No |
| Cadmium | No | No | Yes |
| Calcium | UT | UT | UT |
| Cesium | UT | UT | UT |
| Chromium | Yes | Yes | Yes |
| Cobalt | No | UT | No |
| Copper | No | No | Yes |
| Iron | UT | UT | UT |
| Lead | No | No | Yes |
| Lithium | Yes | UT | No |
| Magnesium | UT | UT | UT |
| Manganese | Yes | UT | Yes |
| Mercury | No | No | Yes |
| Molybdenum | No | UT | Yes |
| Nickel | Yes | No | Yes |
| Potassium | UT | UT | UT |
| Selenium | No | No | No |
| Silica | UT | UT | UT |
| Silver | No | UT | UT |
| Sodium | UT | UT | UT |
| Strontium | UT | UT | No |
| Titanium | UT | UT | UT |
| Uranium | No | UT | No |
| Vanadium | Yes | UT | Yes |
| Zinc | Yes | No | Yes |
| Radionuclides (pCi/g) | | | |
| Americium-241 | UT | UT | No |
| Cesium-137 | UT | UT | No |
| Gross Alpha | UT | UT | UT |
| Gross Beta | UT | UT | UT |
| Plutonium-239/240 | UT | UT | No |
| Radium-226 | UT | UT | No |
| Radium-228 | UT | UT | No |
| Strontium-89/90 | UT | UT | No |
| Uranium-233/234 | UT | UT | No |
| Uranium-235 | UT | UT | No |
| Uranium-238 | UT | UT | No |

UT - Uncertain toxicity; no ESL available (assessed in Section 10).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.3
Statistical Distributions and Comparison to Background for SEEU Surface Soil^a (Non-PMJM)

| Analyte | Statistical Distribution Testing Results | | | | | | Background Comparison Test Results | | |
|-------------------|--|---|-------------|----------------------|---|-------------|------------------------------------|----------|------------------|
| | Total No. of Samples | Background Distribution Recommended by ProUCL | Detects (%) | Total No. of Samples | SEEU Distribution Recommended by ProUCL | Detects (%) | Test | 1 - p | Retain as ECOI? |
| Inorganics | | | | | | | | | |
| Aluminum | 20 | NORMAL | 100 | 19 | NORMAL | 100 | t-Test | 2.09E-04 | Yes |
| Arsenic | 20 | NORMAL | 100 | 19 | GAMMA | 100 | WRS | 0.177 | No |
| Barium | 20 | NORMAL | 100 | 19 | NORMAL | 100 | t-Test | 3.17E-04 | Yes |
| Boron | N/A | N/A | N/A | 14 | NORMAL | 100 | N/A | N/A | Yes ^b |
| Cadmium | 20 | NONPARAMETRIC | 65 | 19 | GAMMA | 68.4 | WRS | 0.997 | No |
| Chromium | 20 | NORMAL | 100 | 19 | NORMAL | 100 | t-Test | 8.45E-05 | Yes |
| Copper | 20 | NONPARAMETRIC | 100 | 19 | NORMAL | 100 | WRS | 0.020 | Yes |
| Lead | 20 | NORMAL | 100 | 19 | NORMAL | 100 | t-Test | 0.999 | No |
| Lithium | 20 | NORMAL | 100 | 16 | NORMAL | 93.8 | t-Test | 4.11E-05 | Yes |
| Manganese | 20 | NORMAL | 100 | 19 | NONPARAMETRIC | 100 | WRS | 2.10E-04 | Yes |
| Mercury | 20 | NONPARAMETRIC | 40 | 16 | GAMMA | 25 | WRS | 1.000 | No |
| Molybdenum | 20 | NORMAL | 0 | 18 | LOGNORMAL | 77.8 | N/A | N/A | Yes ^b |
| Nickel | 20 | NORMAL | 100 | 19 | GAMMA | 100 | WRS | 2.91E-05 | Yes |
| Vanadium | 20 | NORMAL | 100 | 19 | GAMMA | 100 | WRS | 9.28E-05 | Yes |
| Zinc | 20 | NORMAL | 100 | 19 | NONPARAMETRIC | 100 | WRS | 0.089 | Yes |

^a EU data used for background comparisons do not include data from background locations.

^b Statistical comparisons to background cannot be performed. The analyte is retained as an ECOI for further evaluation.

N/A - Not applicable. Background comparison was not performed because background data were not available or detection frequency of an analyte in EU or background data sets was less than 20 percent.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.4
Statistical Concentrations in Surface Soil

| Analyte | Number of Samples | Mean | Median | 75 th Percentile | 95 th Percentile | 95UCL | 95UTL | Maximum |
|-------------------|-------------------|--------|--------|-----------------------------|-----------------------------|--------|--------|---------|
| Inorganics | | | | | | | | |
| Aluminum | 19 | 15,362 | 15,000 | 18,000 | 23,200 | 17,323 | 24,966 | 25,000 |
| Barium | 19 | 141 | 130 | 166 | 201 | 157 | 221 | 210 |
| Boron | 14 | 5.95 | 5.70 | 6.40 | 8.51 | 6.64 | 9.04 | 8.70 |
| Chromium | 19 | 17.0 | 16.0 | 20.5 | 26.1 | 19.1 | 27.5 | 27.0 |
| Copper | 19 | 15.2 | 15.9 | 17.5 | 19.6 | 16.7 | 22.7 | 25.0 |
| Lithium | 16 | 13.3 | 15.0 | 17.3 | 20.0 | 15.7 | 24.1 | 23.0 |
| Manganese | 19 | 392 | 340 | 399 | 670 | 639 | 1,300 | 1,300 |
| Molybdenum | 18 | 1.14 | 0.940 | 1.20 | 2.31 | 1.39 | 2.64 | 2.35 |
| Nickel | 19 | 16.3 | 16.0 | 19.0 | 23.3 | 18.7 | 35.0 | 35.0 |
| Vanadium | 19 | 50.5 | 43.2 | 62.5 | 84.2 | 61.1 | 140 | 140 |
| Zinc | 19 | 53.6 | 57.0 | 65.0 | 70.1 | 59.6 | 71.0 | 71.0 |

*Maximum = Maximum proxy result; may be MDC or reporting limit greater than MDC.

UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

UTL = 95% upper confidence limit on the 90th percentile value, unless the MDC < UTL, then the MDC is used as the UTL.

Table 7.5
Upper-Bound Exposure Point Concentration Comparison to Limiting ESLs in the SEEU Surface Soil

| Analyte | Small Home Range Receptors | | | Large Home Range Receptors | | |
|---------------------------|----------------------------|--------------|----------|----------------------------|--------------|----------|
| | EPC (95UTL) | Limiting ESL | EPC-ESL? | EPC (95UCL) | Limiting ESL | EPC-ESL? |
| Inorganics (mg/kg) | | | | | | |
| Aluminum | 24,966 | 50 | Yes | 17,323 | N/A | N/A |
| Barium | 210 ^c | 222 | No | 157 | 4,770 | No |
| Boron | 8.7 ^c | 0.5 | Yes | 6.64 | 314 | No |
| Chromium | 27 ^c | 0.4 | Yes | 19.1 | 68.5 | No |
| Copper | 22.7 | 8.25 | Yes | 16.7 | 3,000 | No |
| Lithium | 23.0 | 2 | Yes | 15.7 | 2,560 | No |
| Manganese | 1,300 | 486 | Yes | 639 | 2,510 | No |
| Molybdenum | 2.35 ^c | 1.90 | Yes | 1.39 | 8.18 | No |
| Nickel | 35.0 | 0.431 | Yes | 18.7 | 1.86 | Yes |
| Vanadium | 140 | 2 | Yes | 61.1 | 121 | No |
| Zinc | 71 | 0.646 | Yes | 59.6 | 431 | No |

^aThreshold ESL, if available, for the plant, invertebrate, deer mouse, prairie dog, dove, or kestrel receptors.

^bThreshold ESL, if available, for the coyote and mule deer receptors.

^cThe UTL was greater than the MDC so the MDC was used as the EPC.

If tESL was not available, then the NOAEL ESL was used.

N/A = Not applicable; ESL not available.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

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Table 7.6

Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Small Home Range Receptors in the SEEU Surface Soil

| Analyte | Small Home Range | Receptor-Specific ESLs | | | | | | | |
|---------------------------|----------------------------------|------------------------|-----------------------------|---------------------|------------------------------|--------------------------------|---------------------------|-----------------------------|-------------|
| | Receptor 95 th UFL | Terrestrial Plant | Terrestrial Invertebrate | American Kestrel | Mourning Dove (herbivore) | Mourning Dove (insectivore) | Deer Mouse (herbivore) | Deer Mouse (insectivore) | Prairie Dog |
| Inorganics (mg/kg) | | | | | | | | | |
| Aluminum | 24,966 | 50 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Boron | 8.70 | 0.5 | N/A | 167 | 30.3 | 115 | 62.1 | 422 | 237 |
| Chromium | 27.0 | 1 | 0.4 | 14.2 | 24.6 | 1.34 | 281 | 15.9 | 703 |
| Copper | 22.7 | 100 | 50.0 | 164 | 28.8 | 8.25 | 295 | 605 | 838 |
| Lithium | 23.0 | 2 | N/A | N/A | N/A | N/A | 1880 | 610 | 3180 |
| Manganese | 1,300 | 500 | N/A | 9920 | 1030 | 2630 | 486 | 4080 | 1519 |
| Molybdenum | 2.35 | 2 | N/A | 76.7 | 44.4 | 6.97 | 8.68 | 1.90 | 27.1 |
| Nickel | 35.0 | 30 | 200 | 89.9 | 320 | 7.84 | 16.4 | 0.431 | 38.3 |
| Vanadium | 140 | 2 | N/A | 1510 | 503 | 274 | 63.7 | 29.9 | 83.5 |
| Zinc | 71 | 50 | 200 | 113 | 109 | 0.646 | 171 | 5.29 | 1,174 |

*Threshold ESL, if available, for that receptor.

N/A = Not applicable; ESL not available.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.7

Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Large Home Range Receptors in the
SEEU Surface Soil

| Analyte | Large Home Range Receptor 95 th UCL | Receptor-Specific ESLs | | | |
|--------------------|--|------------------------|-----------------------|------------------------|-------------------------|
| | | Mule Deer | Coyote (carnivore) | Coyote (generalist) | Coyote (insectivore) |
| Inorganics (mg/kg) | | | | | |
| Nickel | 18.7 | 124 | 90.9 | 6.02 | 1.86 |

*Threshold ESL, if available, for that receptor.

Bold = Receptors of potential concern.

Table 7.8
Summary of ECOPC Screening Steps for Surface Soil Non-PMJM Receptors

| Analyte | Exceeds Any NOAEL ESL ^a | Detection Frequency ≥5% | Exceeds Background ^b | Upper-Bound EPC > Limiting ESL ^b | Professional Judgment: Retain? | ECOPC? | Receptor(s) of Potential Concern |
|----------------------|--|-------------------------------|------------------------------------|---|--------------------------------------|--------|-------------------------------------|
| Inorganics | | | | | | | |
| Aluminum | Yes | Yes | Yes | Yes | No | No | -- |
| Antimony | No | -- | -- | -- | -- | No | -- |
| Arsenic | Yes | Yes | No | -- | -- | No | -- |
| Barium | Yes | Yes | Yes | No | -- | No | -- |
| Beryllium | No | -- | -- | -- | -- | No | -- |
| Boron | Yes | Yes | N/A ^c | Yes | No | No | -- |
| Cadmium | Yes | Yes | No | -- | -- | No | -- |
| Calcium | UT | -- | -- | -- | -- | No | -- |
| Cesium | UT | -- | -- | -- | -- | No | -- |
| Chromium | Yes | Yes | Yes | Yes | No | No | -- |
| Cobalt | No | -- | -- | -- | -- | No | -- |
| Copper | Yes | Yes | Yes | Yes | No | No | -- |
| Iron | UT | -- | -- | -- | -- | No | -- |
| Lead | Yes | Yes | No | -- | -- | No | -- |
| Lithium | Yes | Yes | Yes | Yes | No | No | -- |
| Magnesium | UT | -- | -- | -- | -- | No | -- |
| Manganese | Yes | Yes | Yes | Yes | No | No | -- |
| Mercury | Yes | Yes | No | -- | -- | No | -- |
| Molybdenum | Yes | Yes | N/A ^d | Yes | No | No | -- |
| Nickel | Yes | Yes | Yes | Yes | No | No | -- |
| Potassium | UT | -- | -- | -- | -- | No | -- |
| Selenium | No | -- | -- | -- | -- | No | -- |
| Silica | UT | -- | -- | -- | -- | No | -- |
| Silver | No | -- | -- | -- | -- | No | -- |
| Sodium | UT | -- | -- | -- | -- | No | -- |
| Strontium | No | -- | -- | -- | -- | No | -- |
| Titanium | UT | -- | -- | -- | -- | No | -- |
| Uranium | No | -- | -- | -- | -- | No | -- |
| Vanadium | Yes | Yes | Yes | Yes | No | No | -- |
| Zinc | Yes | Yes | Yes | Yes | No | No | -- |
| Radionuclides | | | | | | | |
| Americium-241 | No | -- | -- | -- | -- | No | -- |
| Cesium-137 | No | -- | -- | -- | -- | No | -- |
| Gross Alpha | UT | -- | -- | -- | -- | No | -- |
| Gross Beta | UT | -- | -- | -- | -- | No | -- |
| Plutonium-239/240 | No | -- | -- | -- | -- | No | -- |
| Radium-226 | No | -- | -- | -- | -- | No | -- |
| Radium-228 | No | -- | -- | -- | -- | No | -- |
| Strontium-89/90 | No | -- | -- | -- | -- | No | -- |
| Uranium-233/234 | No | -- | -- | -- | -- | No | -- |
| Uranium-235 | No | -- | -- | -- | -- | No | -- |
| Uranium-238 | No | -- | -- | -- | -- | No | -- |

^a Based on results of statistical analysis at the 0.1 level of significance.

^b If tESL was not available, then the NOAEL ESL was used.

^c Background boron data is not available so the analyte was retained as an ECOI for further evaluation.

^d A statistical comparison to background could not be performed because all background data are nondetects. The analyte was retained as an ECOI for further evaluation.

-- Screen not performed because analyte was eliminated from further consideration in a previous step.

UT - Uncertain toxicity; no ESL available (assessed in Section 10).

Table 7.9
Comparison of MDCs in SEEU Subsurface Soil to NOAEL
ESLs for Burrowing Receptors

| Analyte | MDC | Prairie Dog NOAEL-ESL | EPC > NOAEL ESL? |
|------------------------------|--------|--------------------------|---------------------|
| Inorganics (mg/kg) | | | |
| Aluminum | 15,300 | N/A | UT |
| Arsenic | 19.1 | 9.35 | Yes |
| Barium | 185 | 3,224 | No |
| Beryllium | 1.10 | 211 | No |
| Cadmium | 0.850 | 198 | No |
| Calcium | 20,000 | N/A | UT |
| Cesium | 2.70 | N/A | UT |
| Chromium | 17.5 | 703 | No |
| Cobalt | 10.8 | 2,461 | No |
| Copper | 21.2 | 838 | No |
| Iron | 34,600 | N/A | UT |
| Lead | 15.7 | 1,850 | No |
| Lithium | 16.1 | 3,178 | No |
| Magnesium | 8,920 | N/A | UT |
| Manganese | 699 | 1519 | No |
| Molybdenum | 10.6 | 27.1 | No |
| Nickel | 29.2 | 38.3 | No |
| Potassium | 2,610 | N/A | UT |
| Selenium | 2.40 | 2.80 | No |
| Silicon | 147 | N/A | UT |
| Sodium | 2,700 | N/A | UT |
| Strontium | 172 | 3,519 | No |
| Vanadium | 58.1 | 83.5 | No |
| Zinc | 76.2 | 1,174 | No |
| Organics (µg/kg) | | | |
| 1,1,1-Trichloroethane | 44.0 | 4.85E+07 | No |
| bis(2-Ethylhexyl)phthalate | 75.0 | 2.76E+06 | No |
| Styrene | 2.00 | 1.53E+06 | No |
| Toluene | 19.0 | 1.22E+06 | No |
| Xylene | 3.00 | 111,663 | No |
| Radionuclides (pCi/g) | | | |
| Americium-241 | 0.014 | 3,890 | No |
| Cesium-134 | -0.004 | N/A | UT |
| Cesium-137 | 0.160 | 20.8 | No |
| Gross Alpha | 20.4 | N/A | UT |
| Gross Beta | 30.4 | N/A | UT |
| Plutonium-239/240 | 0.028 | 6,110 | No |
| Radium-226 | 1.78 | 50.6 | No |
| Radium-228 | 2.01 | 43.9 | No |
| Strontium-89/90 | 0.240 | 22.5 | No |
| Uranium-233/234 | 1.78 | 4,980 | No |
| Uranium-235 | 0.076 | 2,770 | No |
| Uranium-238 | 1.83 | 1,580 | No |

N/A - No ESL available

UT - Uncertain toxicity; no ESL available (assessed in Section 10).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

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Table 7.10
Statistical Distributions and Comparison to Background for SEEU Subsurface Soil

| Analyte | Statistical Distribution Testing Results | | | | | | Background | | |
|---------|--|------------------------------------|-------------|----------------------|------------------------------------|-------------|------------|-------|-----------------|
| | Background | | | SEEU* | | | Test | 1 - p | Retain as ECOI? |
| | Total No. of Samples | Distribution Recommended by ProUCL | Detects (%) | Total No. of Samples | Distribution Recommended by ProUCL | Detects (%) | | | |
| Arsenic | 45 | NONPARAMETRIC | 93 | 6 | NORMAL | 100 | WRS | 0.045 | Yes |

* SEEU data for background comparison do not include any background locations.

Bold = Analyte retained for further consideration in the next ECOPC selection step.

WRS = Wilcoxon Rate Sum Test.

Table 7.11
Statistical Concentrations in Subsurface Soil in the SEEU

| Analyte | Number of Samples | Mean | Median | 75 th Percentile | 95 th Percentile | 95UCL | 95UTL | Maximum ^a |
|------------|-------------------|------|--------|-----------------------------|-----------------------------|-------|-------|----------------------|
| Inorganics | | | | | | | | |
| Arsenic | 6 | 8.10 | 7.40 | 7.48 | 16.2 | 12.8 | 25.3 | 19.1 |

^aMaximum = Maximum proxy result; may be MDC or reporting limit greater than MDC.

UCL = 95% upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

UTL = 95% upper confidence limit on the 90th percentile value, unless the MDC < UTL, then the MDC is used as the UTL.

Table 7.12

Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Burrowing Receptors

| Analyte | Small Home Range Receptor | Receptor-Specific ESL ^a |
|---------------------------|---------------------------|------------------------------------|
| | 95 th UTL | Prairie Dog |
| Inorganics (mg/kg) | | |
| Arsenic | 19.1 ^b | 35.9 |

^aThreshold ESL, if available, for that receptor.

^b The MDC was used as the EPC because the 95 UTL was greater than the MDC (MDC = maximum detected concentration or in some cases, maximum proxy results).

Table 7.13
Summary of ECOPC Screening Steps for Subsurface Soil

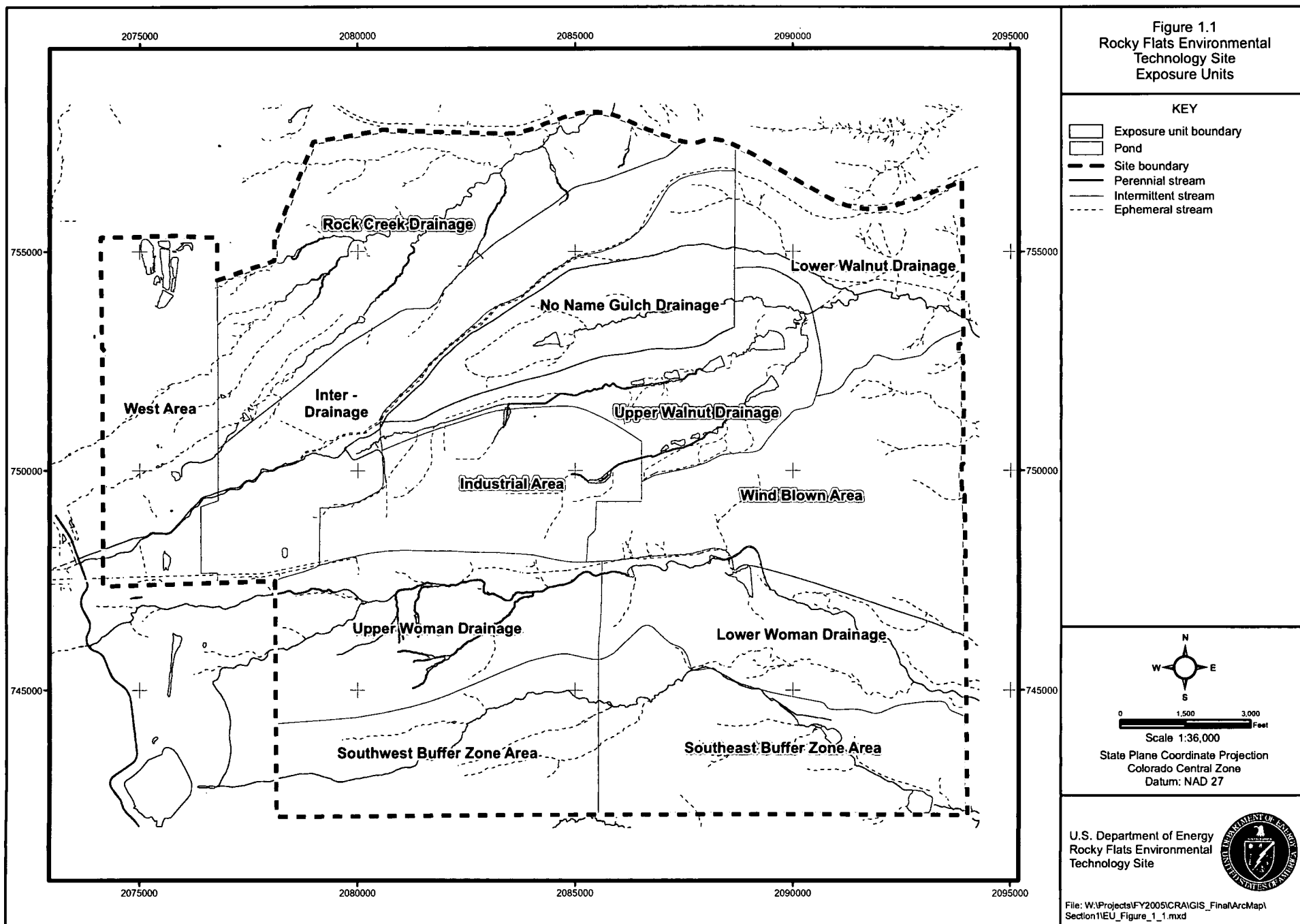
| Analyte | Exceed Any NOAEL ESL? | Frequency of Detection >5% | Exceeds Background | Upper Bound EPC > Limiting ESL? | Professional Judgment - Retain? | Retain as ECOPC |
|----------------------------|--------------------------|----------------------------------|-----------------------|------------------------------------|---------------------------------------|--------------------|
| Inorganics | | | | | | |
| Aluminum | UT | -- | -- | -- | -- | No |
| Arsenic | Yes | Yes | Yes | No | -- | No |
| Barium | No | -- | -- | -- | -- | No |
| Beryllium | No | -- | -- | -- | -- | No |
| Cadmium | No | -- | -- | -- | -- | No |
| Calcium | UT | -- | -- | -- | -- | No |
| Cesium | UT | -- | -- | -- | -- | No |
| Chromium | No | -- | -- | -- | -- | No |
| Cobalt | No | -- | -- | -- | -- | No |
| Copper | No | -- | -- | -- | -- | No |
| Iron | UT | -- | -- | -- | -- | No |
| Lead | No | -- | -- | -- | -- | No |
| Lithium | No | -- | -- | -- | -- | No |
| Magnesium | UT | -- | -- | -- | -- | No |
| Manganese | No | -- | -- | -- | -- | No |
| Molybdenum | No | -- | -- | -- | -- | No |
| Nickel | No | -- | -- | -- | -- | No |
| Potassium | UT | -- | -- | -- | -- | No |
| Selenium | No | -- | -- | -- | -- | No |
| Silicon | UT | -- | -- | -- | -- | No |
| Sodium | UT | -- | -- | -- | -- | No |
| Strontium | No | -- | -- | -- | -- | No |
| Vanadium | No | -- | -- | -- | -- | No |
| Zinc | No | -- | -- | -- | -- | No |
| Organics | | | | | | |
| 1,1,1-Trichloroethane | No | -- | -- | -- | -- | No |
| bis(2-Ethylhexyl)phthalate | No | -- | -- | -- | -- | No |
| Styrene | No | -- | -- | -- | -- | No |
| Toluene | No | -- | -- | -- | -- | No |
| Xylene | No | -- | -- | -- | -- | No |
| Radionuclides | | | | | | |
| Americium-241 | No | -- | -- | -- | -- | No |
| Cesium-137 | No | -- | -- | -- | -- | No |
| Gross Alpha | UT | -- | -- | -- | -- | No |
| Gross Beta | UT | -- | -- | -- | -- | No |
| Plutonium-239/240 | No | -- | -- | -- | -- | No |
| Radium-226 | No | -- | -- | -- | -- | No |
| Radium-228 | No | -- | -- | -- | -- | No |
| Strontium-89/90 | No | -- | -- | -- | -- | No |
| Uranium-233/234 | No | -- | -- | -- | -- | No |
| Uranium-235 | No | -- | -- | -- | -- | No |
| Uranium-238 | No | -- | -- | -- | -- | No |

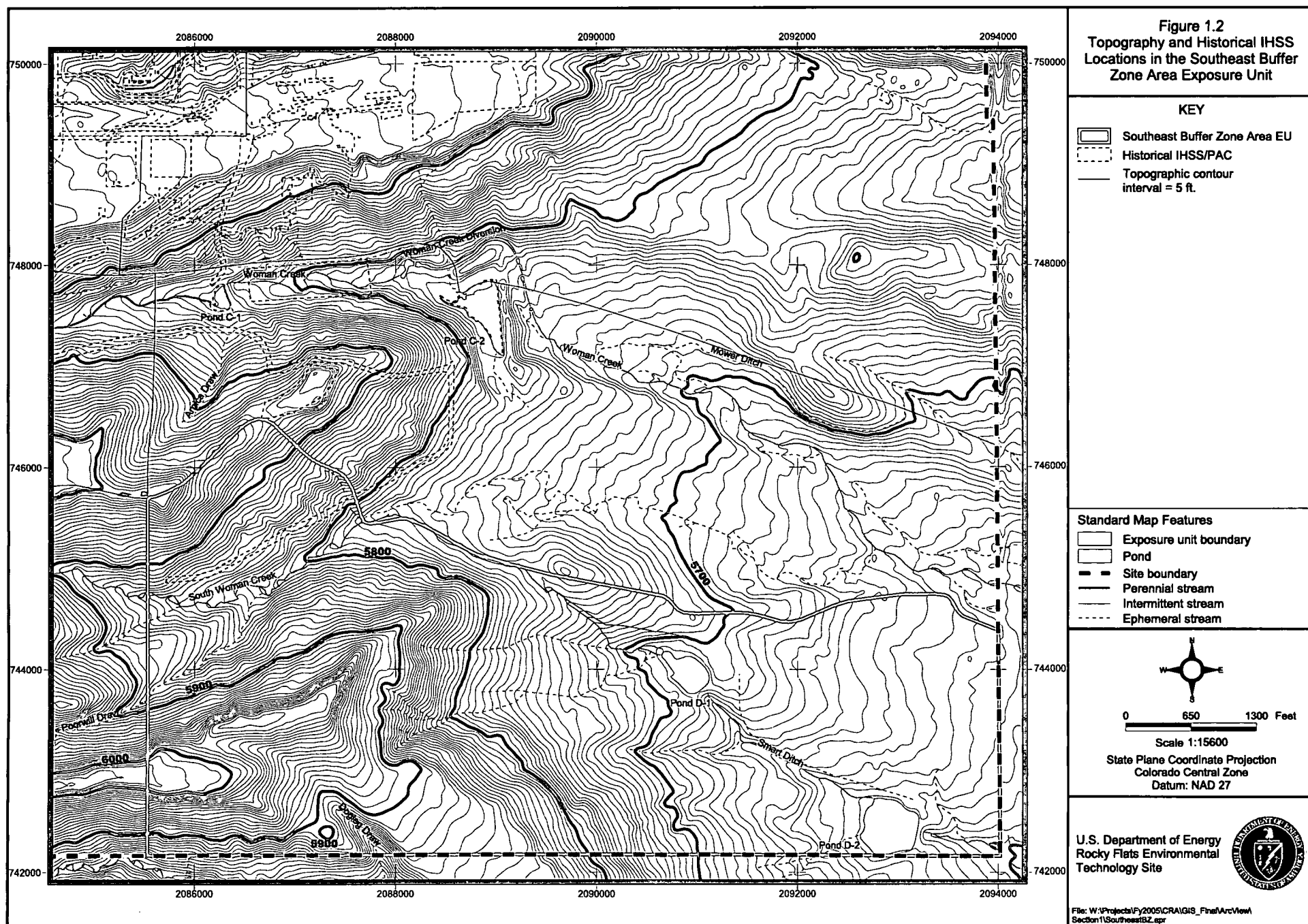
^a Based on results of statistical analysis at the 0.1 level of significance.

-- Screen not performed because analyte was eliminated from further consideration in a previous step.

UT - Uncertain toxicity; no ESL available (assessed in Section 10).

FIGURES





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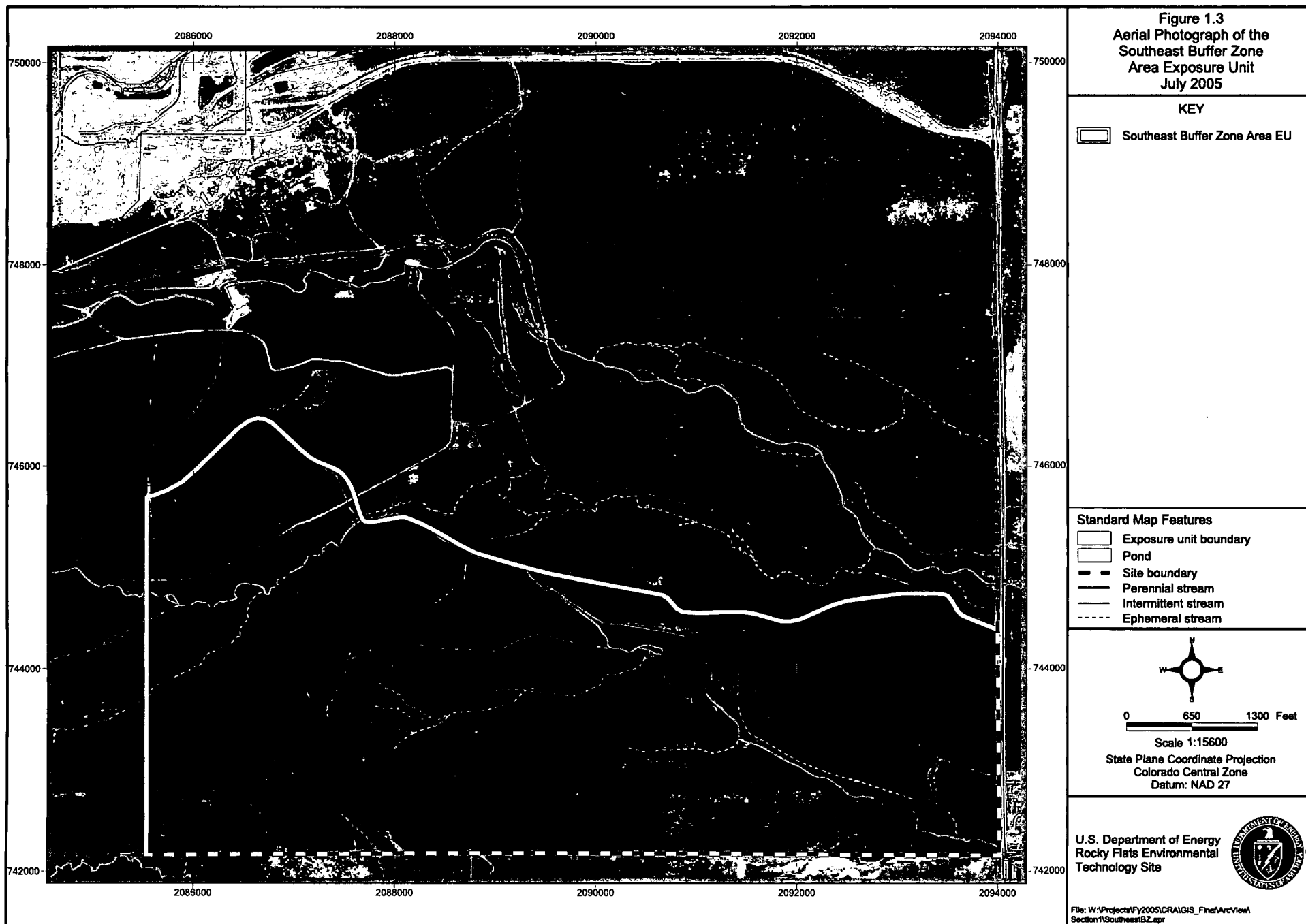


Figure 1.3
Aerial Photograph of the
Southeast Buffer Zone
Area Exposure Unit
July 2005

KEY

Southeast Buffer Zone Area EU

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream



0 650 1300 Feet

Scale 1:15600

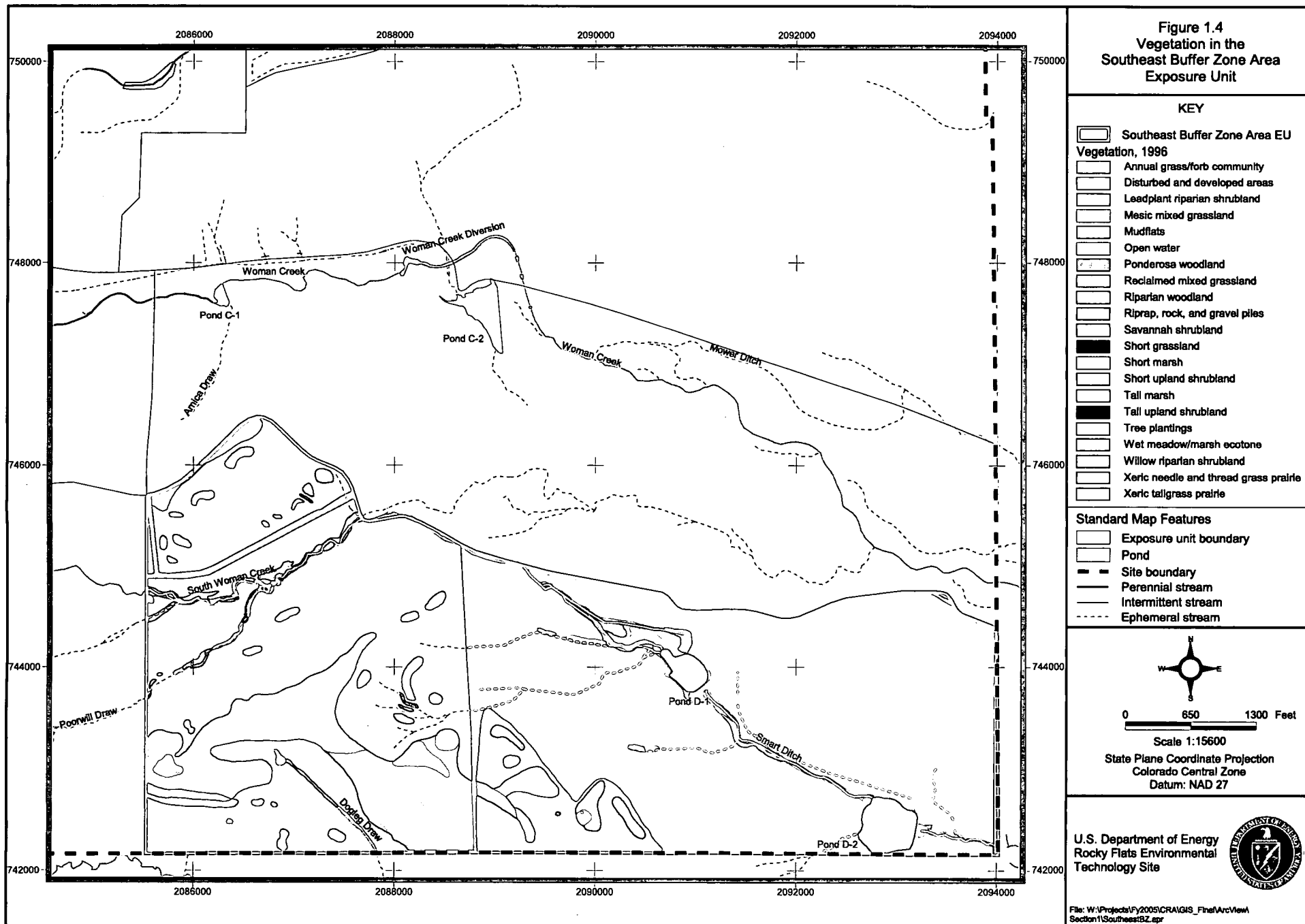
State Plane Coordinate Projection
 Colorado Central Zone
 Datum: NAD 27

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 Rocky Flats Environmental
 Technology Site

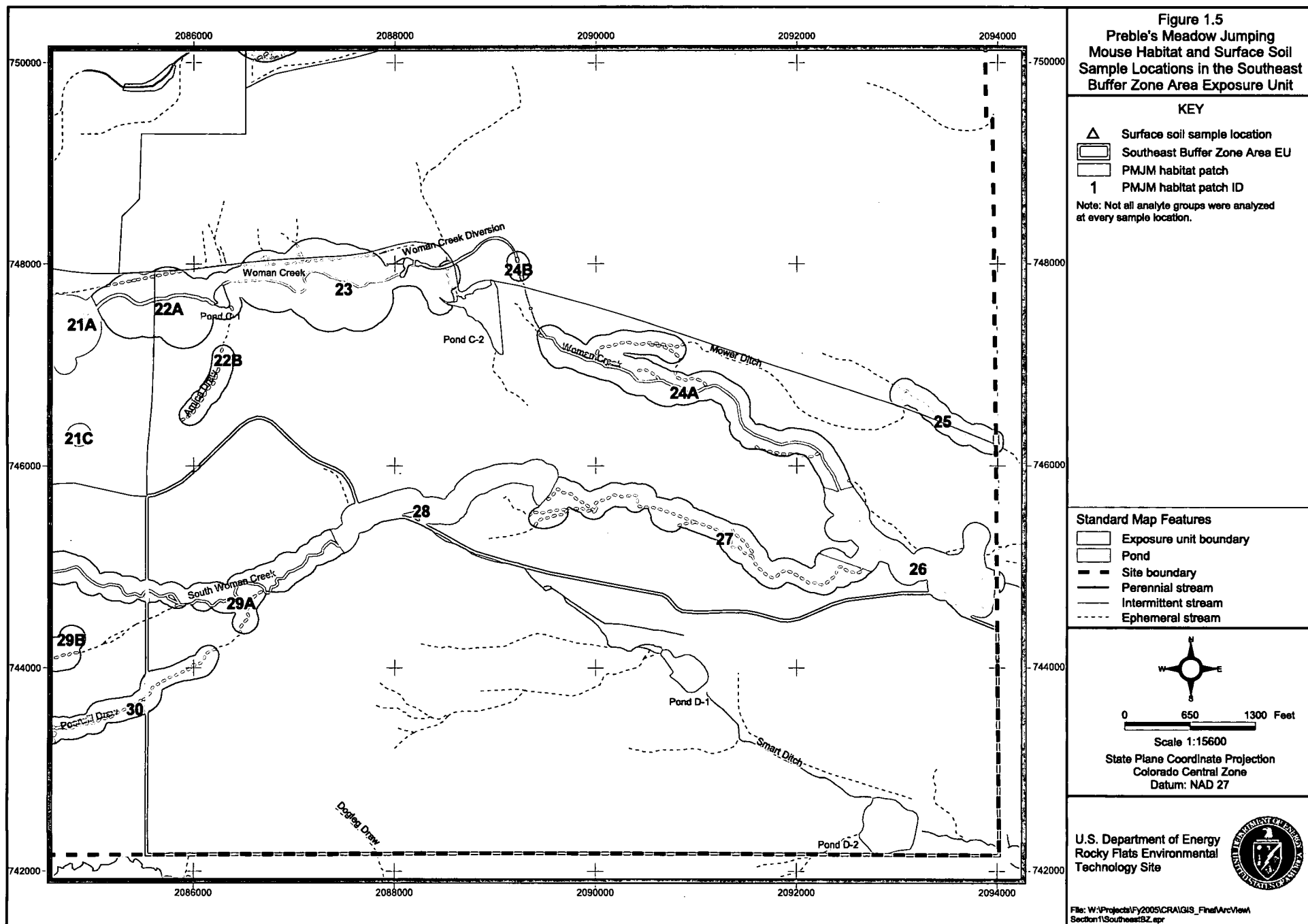


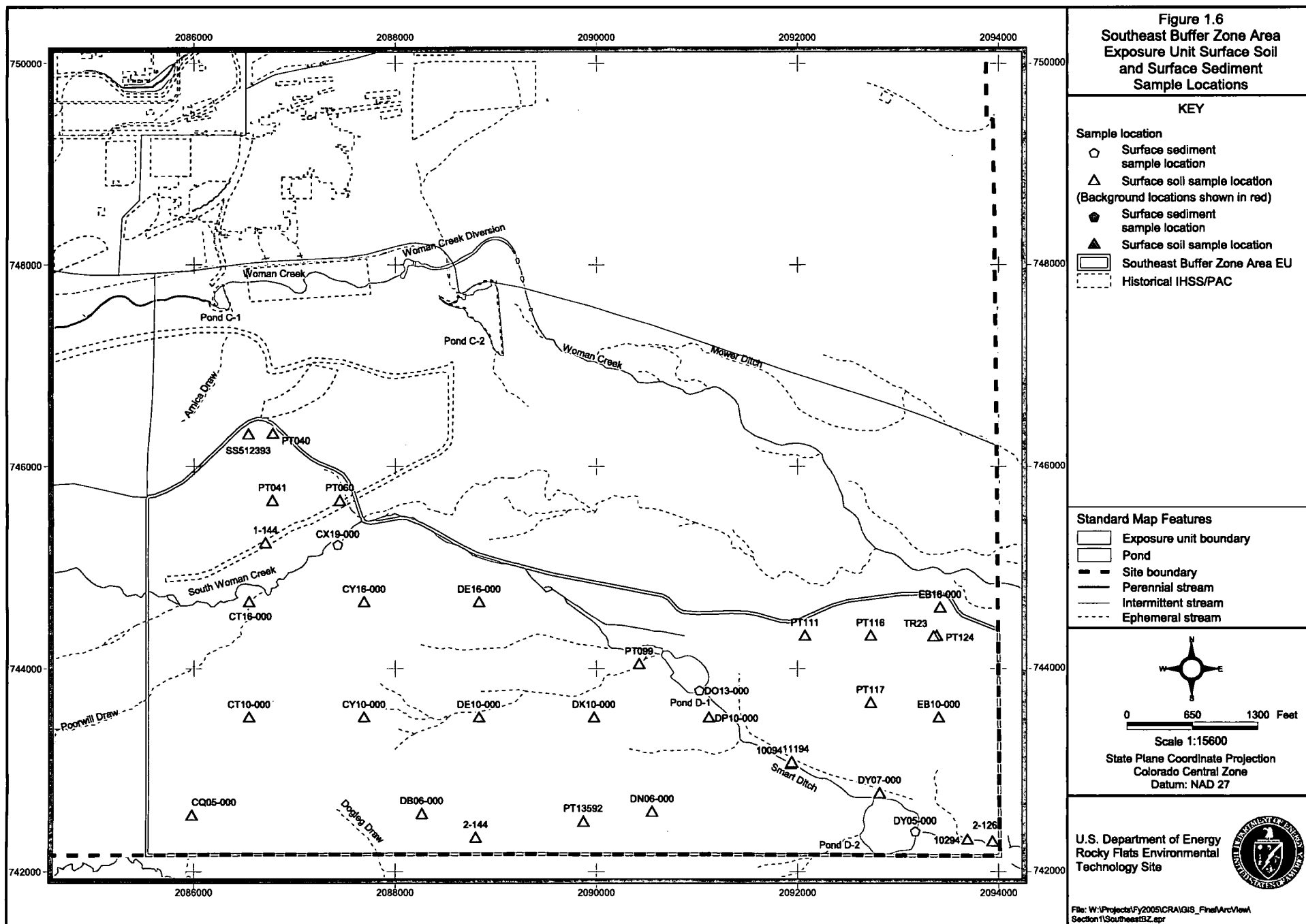
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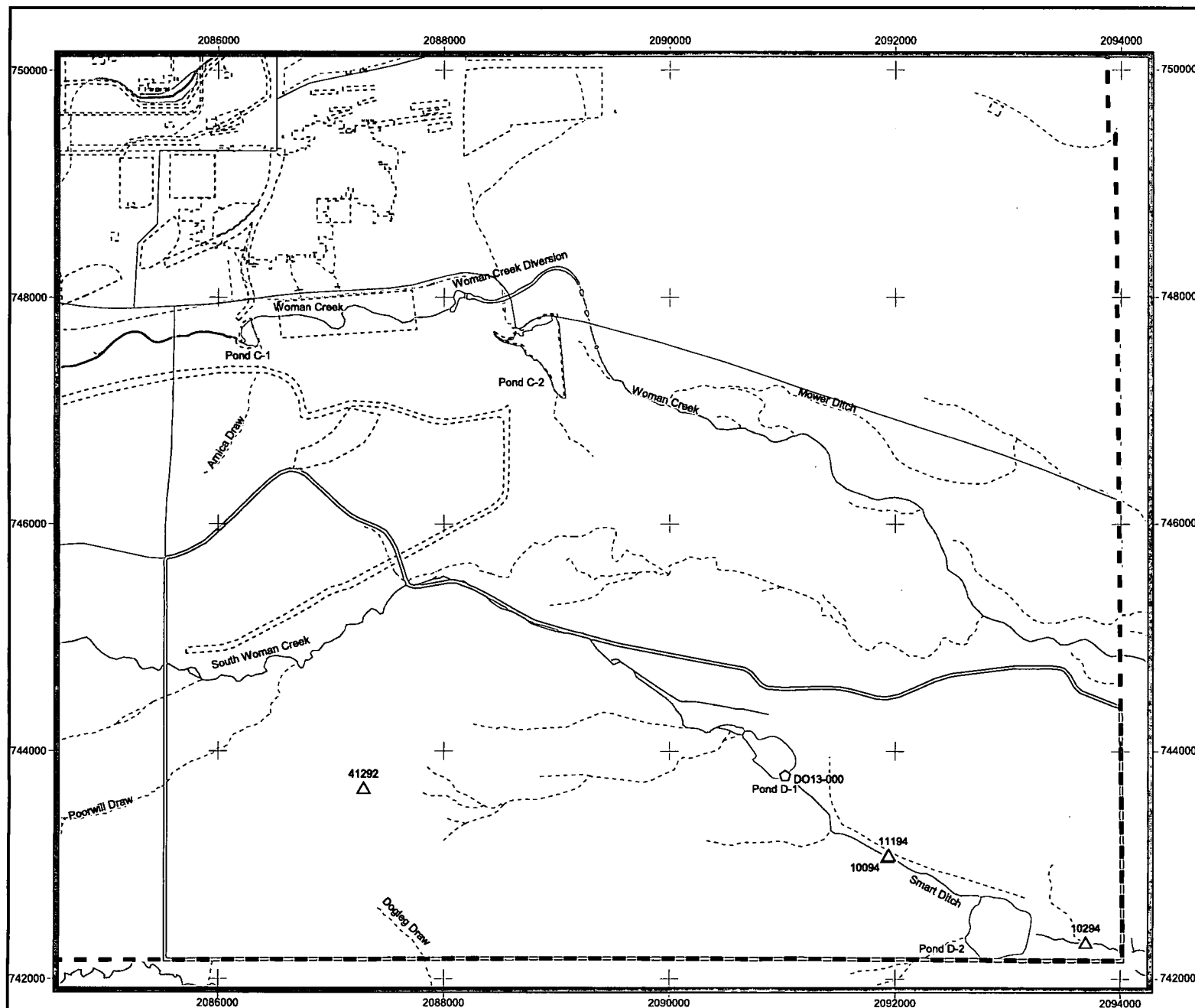


Figure 1.7
Southeast Buffer Zone Area
Exposure Unit Subsurface Soil
and Subsurface Sediment
Sample Locations

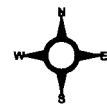
KEY

Sample location

- Subsurface sediment sample location
- △ Subsurface soil sample location
- (Background locations shown in red)
- Subsurface sediment sample location
- ▲ Subsurface soil sample location
- Southeast Buffer Zone Area EU
- Historical IHSS/PAC

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- - - Intermittent stream
- - - Ephemeral stream



0 650 1300 Feet

Scale 1:15600

State Plane Coordinate Projection
 Colorado Central Zone
 Datum: NAD 27

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COMPREHENSIVE RISK ASSESSMENT

SOUTHEAST BUFFER ZONE AREA EXPOSURE UNIT

VOLUME 13: ATTACHMENT 1

Detection Limit Screen

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ACRONYMS AND ABBREVIATIONS

| | |
|-------|--|
| µg/kg | micrograms per kilogram |
| µg/L | micrograms per liter |
| CD | compact disc |
| CRA | Comprehensive Risk Assessment |
| ERA | Ecological Risk Assessment |
| ESL | ecological screening level |
| EU | Exposure Unit |
| HHRA | Human Health Risk Assessment |
| IHSS | Individual Hazardous Substance Site |
| mg/kg | milligrams per kilogram |
| N/A | not available or not applicable |
| NOAEL | no observed adverse effect level |
| PAC | Potential Area of Concern |
| pCi/g | picocuries per gram |
| PRG | preliminary remediation goal |
| SEEU | Southeast Buffer Zone Area Exposure Unit |
| TIC | tentatively identified compound |
| VOC | volatile organic compound |
| WRW | wildlife refuge worker |

1.0 EVALUATION OF DETECTION LIMITS FOR NONDETECTED ANALYTES IN THE SOUTHEAST BUFFER ZONE EXPOSURE UNIT

The detection limits for analytes that are either not detected or detected in less than 5 percent of the samples collected from the media used in the Human Health Risk Assessment (HHRA) or the Ecological Risk Assessment (ERA) are reviewed in this attachment. The detection limits for surface soil/surface sediment and subsurface soil/subsurface sediment samples are compared to human health preliminary remediation goals (PRGs) for the wildlife refuge worker (WRW). The detection limits for media evaluated in the ERA are compared to the minimum ecological screening level (ESL) for a variety of ecological receptors (surface soil) and the prairie dog no observed adverse effect level (NOAEL) ESL (subsurface soil). The results of these comparisons are presented in Tables A1.1 through A1.4.

Nondetects and the reported detection limits (referred to as “reported result” in the following sections of this attachment) are listed in these tables for each medium in the Southeast Buffer Zone (BZ) Area Exposure Unit (EU) (SEEU) and compared to medium-specific human health PRGs for the WRW and ESLs for a variety of ecological receptors. Detection limits that exceed the respective PRGs and ESLs are noted and discussed.

Analytes that were not detected in any samples collected in each media are referred to as nondetected analytes. The nondetected chemicals are reported in this attachment at the lowest level at which the chemical may be accurately and reproducibly quantified, taking into account the sample characteristics, sample collection, sample preparation, and analytical adjustments.

1.1 Comparison of Maximum Detection Limits for Nondetected Analytes to Preliminary Remediation Goals

1.1.1 Surface Soil/Surface Sediment

The maximum reported results for three nondetected analytes in surface soil/surface sediment are greater than the PRG (Table A1.1). Therefore, there is some uncertainty associated with the reported results for these analytes in the SEEU.

For benzo(a)pyrene, dibenz(a,h)anthracene and n-nitroso-di-n-propylamine, only one sample was collected and it exceeded the PRG. For each of these analytes, the maximum reported result was less than twice the PRG. The slight exceedance of the maximum reported results for benzo(a)pyrene, dibenz(a,h)anthracene, and n-nitroso-di-n-propylamine compared to the PRGs is not expected to have significant impacts on the results of the risk assessment.

PRGs were not available for several nondetected organic analytes in surface soil/surface sediment (Table A1.1). Because PRGs were available for most of the nondetected organics in surface soil/surface sediment, and the maximum reported results for these analytes were much lower than the PRGs, the lack of PRGs for less than half of the organics is unlikely to have a significant effect on the results of the risk assessment. In addition, the fact that no identified source exists for these analytes in the surface soil/surface sediment at the SEEU suggests there is an acceptable level of uncertainty associated with the reported results for these nondetected analytes.

1.1.2 Subsurface Soil/Subsurface Sediment

No nondetected analytes exceeded the PRG in subsurface soil/subsurface sediment (Table A1.2).

PRGs were not available for several nondetected organic analytes in subsurface soil/subsurface sediment (Table A1.2). Because PRGs were available for most of the nondetected organics in subsurface soil/subsurface sediment, and the maximum reported results for these analytes were much lower than the PRGs, the lack of PRGs for less than half of the organics is unlikely to have a significant effect on the results of the risk assessment. In addition, the fact that no identified source exists for these analytes in the subsurface soil/subsurface sediment at the SEEU suggests there is an acceptable level uncertainty associated with the reported results for these nondetected analytes.

1.2 Comparison of Maximum Reported Results for Nondetected Analytes to Ecological Screening Levels

1.2.1 Surface Soil

The maximum reported results for 25 nondetected analytes in surface soil are greater than the ESL (Table A1.3). Therefore, there is some uncertainty associated with the reported results for these analytes in the SEEU.

The maximum reported result for thallium, tin, 2,4,6-trichlorophenol, 2-chlorophenol, 4,4'-DDE, 4,6-dinitro-2-methylphenol, benzo(a)pyrene, bis(2-ethylhexyl)phthalate, dieldrin, hexachlorobutadiene, hexachloroethane, PCB-1016, PCB-1221, PCB-1232, PCB-1242, PCB-1248, PCB-1254, and PCB-1260 exceeds the ESL by less than 10 times. For 2,4-dinitrotoluene, 4,4'-DDT, endrin, endrin ketone, and pentachlorophenol, the maximum reported result exceeded the ESL by less than 30 times. For di-n-butylphthalate, the maximum reported result was 710 micrograms per kilogram ($\mu\text{g}/\text{kg}$) and the ESL was 15.9 $\mu\text{g}/\text{kg}$. Hexachlorobenzene had a maximum reported result of 710 $\mu\text{g}/\text{kg}$ and an ESL of 7.73 $\mu\text{g}/\text{kg}$.

ESLs were not available for several nondetected organic analytes in surface soil (Table A1.3). Because ESLs were available for most of the nondetected organics in surface soil, and the maximum reported results for these analytes were much lower than the ESLs, the lack of ESLs for less than half of the organics is unlikely to have a significant effect on the results of the risk assessment. In addition, the fact that no identified source exists for these analytes in the surface soil at the SEEU suggests there is an acceptable level of uncertainty associated with the reported results for these nondetected analytes.

1.2.2 Subsurface Soil

The minimum and maximum reported results for all nondetected analytes in subsurface soil were below their respective ESLs (Table A1.4).

ESLs were not available for several of the organics and one inorganic in subsurface soil (Table A1.4). Because the maximum reported results for nondetected analytes with ESLs available were much lower than the ESLs, the lack of ESLs for several of the organics

and one inorganic is not likely to have a significant effect on the results of the risk assessment.

TABLES

Table A1.1

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Soil/Surface Sediment^a

| Analyte | Range of Reported Results | Total Number of Results | PRC | Maximum Reported Result > PRC? |
|------------------------------|---------------------------|-------------------------|------------|--------------------------------|
| Inorganics (mg/kg) | | | | |
| Tin | 0.86 - 22.4 | 21 | 66,652 | No |
| Organics (ug/kg) | | | | |
| 1,2,4-Trichlorobenzene | 710 | 1 | 151,360 | No |
| 1,2-Dichlorobenzene | 710 | 1 | 2.89E+06 | No |
| 1,3-Dichlorobenzene | 710 | 1 | 3.33E+06 | No |
| 1,4-Dichlorobenzene | 710 | 1 | 91,315 | No |
| 2,4,5-Trichlorophenol | 3,600 | 1 | 8.01E+06 | No |
| 2,4,6-Trichlorophenol | 710 | 1 | 272,055 | No |
| 2,4-Dichlorophenol | 710 | 1 | 240,431 | No |
| 2,4-Dimethylphenol | 710 | 1 | 1.60E+06 | No |
| 2,4-Dinitrophenol | 3,600 | 1 | 160,287 | No |
| 2,4-Dinitrotoluene | 710 | 1 | 160,287 | No |
| 2,6-Dinitrotoluene | 710 | 1 | 80,144 | No |
| 2-Chloronaphthalene | 710 | 1 | 6.41E+06 | No |
| 2-Chlorophenol | 710 | 1 | 555,435 | No |
| 2-Methylnaphthalene | 710 | 1 | 320,574 | No |
| 2-Methylphenol | 710 | 1 | 4.01E+06 | No |
| 2-Nitroaniline | 3,600 | 1 | 192,137 | No |
| 2-Nitrophenol | 710 | 1 | N/A | UT |
| 3,3'-Dichlorobenzidine | 1,400 | 1 | 6,667 | No |
| 3-Nitroaniline | 3,600 | 1 | N/A | UT |
| 4,4'-DDD | 35 | 1 | 15,528 | No |
| 4,4'-DDE | 35 | 1 | 10,961 | No |
| 4,4'-DDT | 35 | 1 | 10,927 | No |
| 4,6-Dinitro-2-methylphenol | 3,600 | 1 | 8,014 | No |
| 4-Bromophenyl-phenylether | 710 | 1 | N/A | UT |
| 4-Chloro-3-methylphenol | 710 | 1 | N/A | UT |
| 4-Chloroaniline | 710 | 1 | 320,574 | No |
| 4-Chlorophenyl-phenyl ether | 710 | 1 | N/A | UT |
| 4-Methylphenol | 710 | 1 | 400,718 | No |
| 4-Nitroaniline | 3,600 | 1 | 207,917 | No |
| 4-Nitrophenol | 3,600 | 1 | 641,148 | No |
| Acenaphthene | 710 | 1 | 4.44E+06 | No |
| Acenaphthylene | 710 | 1 | N/A | UT |
| Aldrin | 17 | 1 | 176 | No |
| alpha-BHC | 17 | 1 | 570 | No |
| alpha-Chlordane | 170 | 1 | 10,261 | No |
| Anthracene | 710 | 1 | 2.22E+07 | No |
| Benzo(a)anthracene | 710 | 1 | 3,793 | No |
| Benzo(a)pyrene | 710 | 1 | 379 | Yes |
| Benzo(b)fluoranthene | 710 | 1 | 3,793 | No |
| Benzo(g,h,i)perylene | 710 | 1 | N/A | UT |
| Benzo(k)fluoranthene | 710 | 1 | 37,927 | No |
| Benzoic Acid | 3,600 | 1 | 3.21E+08 | No |
| Benzyl Alcohol | 710 | 1 | 2.40E+07 | No |
| beta-BHC | 17 | 1 | 1,995 | No |
| bis(2-Chloroethoxy)methane | 710 | 1 | N/A | UT |
| bis(2-Chloroethyl)ether | 710 | 1 | 3,767 | No |
| bis(2-Chloroisopropyl) ether | 710 | 1 | 59,301 | No |
| bis(2-Ethylhexyl)phthalate | 710 | 1 | 213,750 | No |

Table A1.1

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Soil/Surface Sediment^a

| Analyte | Range of Reported Results | Total Number of Results | PRG | Maximum Reported Result > PRG ^b |
|-----------------------------------|---------------------------|-------------------------|------------|--|
| Butylbenzylphthalate | 710 | 1 | 1.60E+07 | No |
| Chrysene | 710 | 1 | 379,269 | No |
| delta-BHC | 17 | 1 | 570 | No |
| Dibenz(a,h)anthracene | 710 | 1 | 379 | Yes |
| Dibenzofuran | 710 | 1 | 222,174 | No |
| Dieldrin | 35 | 1 | 187 | No |
| Diethylphthalate | 710 | 1 | 6.41E+07 | No |
| Dimethylphthalate | 710 | 1 | 8.01E+08 | No |
| Di-n-butylphthalate | 710 | 1 | 8.01E+06 | No |
| Di-n-octylphthalate | 710 | 1 | 3.21E+06 | No |
| Endosulfan I | 17 | 1 | 480,861 | No |
| Endosulfan II | 35 | 1 | 480,861 | No |
| Endosulfan sulfate | 35 | 1 | 480,861 | No |
| Endrin | 35 | 1 | 24,043 | No |
| Endrin ketone | 35 | 1 | 33,326 | No |
| Fluoranthene | 710 | 1 | 2.96E+06 | No |
| Fluorene | 710 | 1 | 3.21E+06 | No |
| gamma-BHC (Lindane) | 17 | 1 | 2,771 | No |
| gamma-Chlordane | 170 | 1 | 10,261 | No |
| Heptachlor | 17 | 1 | 665 | No |
| Heptachlor epoxide | 17 | 1 | 329 | No |
| Hexachlorobenzene | 710 | 1 | 1,870 | No |
| Hexachlorobutadiene | 710 | 1 | 22,217 | No |
| Hexachlorocyclopentadiene | 710 | 1 | 380,452 | No |
| Hexachloroethane | 710 | 1 | 111,087 | No |
| Indeno(1,2,3-cd)pyrene | 710 | 1 | 3,793 | No |
| Isophorone | 710 | 1 | 3.16E+06 | No |
| Methoxychlor | 170 | 1 | 400,718 | No |
| Naphthalene | 710 | 1 | 1.40E+06 | No |
| Nitrobenzene | 710 | 1 | 43,246 | No |
| N-Nitroso-di-n-propylamine | 710 | 1 | 429 | Yes |
| N-Nitrosodiphenylamine | 710 | 1 | 612,250 | No |
| PCB-1016 | 170 | 1 | 1,349 | No |
| PCB-1221 | 170 | 1 | 1,349 | No |
| PCB-1232 | 170 | 1 | 1,349 | No |
| PCB-1242 | 170 | 1 | 1,349 | No |
| PCB-1248 | 170 | 1 | 1,349 | No |
| PCB-1254 | 350 | 1 | 1,349 | No |
| PCB-1260 | 350 | 1 | 1,349 | No |
| Pentachlorophenol | 3,600 | 1 | 17,633 | No |
| Phenanthrene | 710 | 1 | N/A | UT |
| Phenol | 710 | 1 | 2.40E+07 | No |
| Pyrene | 710 | 1 | 2.22E+06 | No |
| Toxaphene | 350 | 1 | 2,720 | No |

^a No analytes detected in less than 5 percent of samples.

^b Value is the maximum reported result for nondetected analytes.

N/A = Not Available.

UT = Uncertain toxicity.

BOLD = Maximum reported result greater than the PRG.

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Table A1.2

**Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection
Frequency less than 5 Percent in Subsurface Soil/Subsurface Sediment^a**

| Analyte | Range of Reported Results | Total Number of Results | PRG | Maximum Reported Result > PRG ^b |
|-----------------------------|---------------------------------|----------------------------|----------|--|
| Inorganics (mg/kg) | | | | |
| Antimony | 0.73 - 9.7 | 3 | 511 | No |
| Silver | 0.09 - 1.2 | 7 | 6,388 | No |
| Tin | 2.9 - 31.4 | 6 | 766,500 | No |
| Uranium | 1.30 | 1 | 3,833 | No |
| Organics (ug/kg) | | | | |
| 1,1,2,2-Tetrachloroethane | 6 - 6 | 5 | 120,551 | No |
| 1,1,2-Trichloroethane | 6 - 6 | 5 | 322,253 | No |
| 1,1-Dichloroethane | 6 - 6 | 5 | 3.12E+07 | No |
| 1,1-Dichloroethene | 6 - 6 | 5 | 199,706 | No |
| 1,2,4-Trichlorobenzene | 360 - 390 | 3 | 1.74E+06 | No |
| 1,2-Dichlorobenzene | 360 - 390 | 3 | 3.32E+07 | No |
| 1,2-Dichloroethane | 6 - 6 | 5 | 152,603 | No |
| 1,2-Dichloroethene | 6 - 6 | 5 | 1.15E+07 | No |
| 1,2-Dichloropropane | 6 - 6 | 5 | 441,907 | No |
| 1,3-Dichlorobenzene | 360 - 390 | 3 | 3.83E+07 | No |
| 1,4-Dichlorobenzene | 360 - 390 | 3 | 1.05E+06 | No |
| 2,4,5-Trichlorophenol | 1,700 - 1,900 | 3 | 9.22E+07 | No |
| 2,4,6-Trichlorophenol | 360 - 390 | 3 | 3.13E+06 | No |
| 2,4-Dichlorophenol | 360 - 390 | 3 | 2.76E+06 | No |
| 2,4-Dimethylphenol | 360 - 390 | 3 | 1.84E+07 | No |
| 2,4-Dinitrophenol | 1,700 - 1,900 | 3 | 1.84E+06 | No |
| 2,4-Dinitrotoluene | 360 - 390 | 3 | 1.84E+06 | No |
| 2,6-Dinitrotoluene | 360 - 390 | 3 | 921,651 | No |
| 2-Butanone | 11 - 12 | 5 | 5.33E+08 | No |
| 2-Chloronaphthalene | 360 - 390 | 3 | 7.37E+07 | No |
| 2-Chlorophenol | 360 - 390 | 3 | 6.39E+06 | No |
| 2-Hexanone | 11 - 12 | 5 | N/A | UT |
| 2-Methylnaphthalene | 360 - 390 | 3 | 3.69E+06 | No |
| 2-Methylphenol | 360 - 390 | 3 | 4.61E+07 | No |
| 2-Nitroaniline | 1,700 - 1,900 | 3 | 2.21E+06 | No |
| 2-Nitrophenol | 360 - 390 | 3 | N/A | UT |
| 3,3'-Dichlorobenzidine | 710 - 780 | 3 | 76,667 | No |
| 3-Nitroaniline | 1,700 - 1,900 | 3 | N/A | UT |
| 4,6-Dinitro-2-methylphenol | 1,700 - 1,900 | 3 | 92,165 | No |
| 4-Bromophenyl-phenylether | 360 - 390 | 3 | N/A | UT |
| 4-Chloro-3-methylphenol | 360 - 390 | 3 | N/A | UT |
| 4-Chloroaniline | 360 - 390 | 3 | 3.69E+06 | No |
| 4-Chlorophenyl-phenyl ether | 360 - 390 | 3 | N/A | UT |
| 4-Methyl-2-pentanone | 11 - 12 | 5 | 9.57E+08 | No |
| 4-Methylphenol | 360 - 390 | 3 | 4.61E+06 | No |
| 4-Nitroaniline | 1,700 - 1,900 | 3 | 2.39E+06 | No |
| 4-Nitrophenol | 1,700 - 1,900 | 3 | 7.37E+06 | No |
| Acenaphthene | 360 - 390 | 3 | 5.10E+07 | No |
| Acenaphthylene | 360 - 390 | 3 | N/A | UT |
| Acetone | 11 - 12 | 5 | 1.15E+09 | No |
| Anthracene | 360 - 390 | 3 | 2.55E+08 | No |
| Benzene | 6 - 6 | 5 | 270,977 | No |
| Benzo(a)anthracene | 360 - 390 | 3 | 43,616 | No |
| Benzo(a)pyrene | 360 - 390 | 3 | 4,357 | No |
| Benzo(b)fluoranthene | 360 - 390 | 3 | 43,616 | No |
| Benzo(g,h,i)perylene | 360 - 390 | 3 | N/A | UT |
| Benzo(k)fluoranthene | 360 - 390 | 3 | 436,159 | No |
| Benzoic Acid | 1,700 - 1,900 | 3 | 3.69E+09 | No |
| Benzyl Alcohol | 360 - 390 | 3 | 2.76E+08 | No |
| bis(2-Chloroethoxy)methane | 360 - 390 | 3 | N/A | UT |

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Table A1.2

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Subsurface Soil/Subsurface Sediment^a

| Analyte | Range of Reported Results | Total Number of Results | PRG | Maximum Reported Result > PRG? ^b |
|-----------------------------|---------------------------|-------------------------|----------|---|
| bis(2-Chloroethyl)ether | 360 - 390 | 3 | 43,315 | No |
| bis(2-Chloroisopropyl)ether | 360 - 390 | 3 | 681,967 | No |
| Bromodichloromethane | 6 - 6 | 5 | 771,304 | No |
| Bromoform | 6 - 6 | 5 | 4.83E+06 | No |
| Bromomethane | 11 - 12 | 5 | 241,033 | No |
| Butylbenzylphthalate | 360 - 390 | 3 | 1.84E+08 | No |
| Carbon Disulfide | 6 - 6 | 5 | 1.88E+07 | No |
| Carbon Tetrachloride | 6 - 6 | 5 | 97,124 | No |
| Chlorobenzene | 6 - 6 | 5 | 7.67E+06 | No |
| Chloroethane | 11 - 12 | 5 | 1.65E+07 | No |
| Chloroform | 6 - 6 | 5 | 90,270 | No |
| Chloromethane | 11 - 12 | 5 | 1.32E+06 | No |
| Chrysene | 360 - 390 | 3 | 4.36E+06 | No |
| cis-1,3-Dichloropropene | 6 - 6 | 5 | 223,462 | No |
| Dibenz(a,h)anthracene | 360 - 390 | 3 | 4,362 | No |
| Dibenzofuran | 360 - 390 | 3 | 2.56E+06 | No |
| Dibromochloromethane | 6 - 6 | 5 | 569,296 | No |
| Diethylphthalate | 360 - 390 | 3 | 7.37E+08 | No |
| Dimethylphthalate | 360 - 390 | 3 | 9.22E+09 | No |
| Di-n-butylphthalate | 360 - 390 | 3 | 9.22E+07 | No |
| Di-n-octylphthalate | 360 - 390 | 3 | 3.69E+07 | No |
| Ethylbenzene | 6 - 6 | 5 | 6.19E+07 | No |
| Fluoranthene | 360 - 390 | 3 | 3.40E+07 | No |
| Fluorene | 360 - 390 | 3 | 3.69E+07 | No |
| Hexachlorobenzene | 360 - 390 | 3 | 21,508 | No |
| Hexachlorobutadiene | 360 - 390 | 3 | 255,500 | No |
| Hexachlorocyclopentadiene | 360 - 390 | 3 | 4.38E+06 | No |
| Hexachloroethane | 360 - 390 | 3 | 1.28E+06 | No |
| Indeno(1,2,3-cd)pyrene | 360 - 390 | 3 | 43,616 | No |
| Isophorone | 360 - 390 | 3 | 3.63E+07 | No |
| Methylene Chloride | 6 - 6 | 5 | 3.13E+06 | No |
| Naphthalene | 360 - 390 | 3 | 1.61E+07 | No |
| Nitrobenzene | 360 - 390 | 3 | 497,333 | No |
| N-Nitroso-di-n-propylamine | 360 - 390 | 3 | 4,929 | No |
| N-Nitrosodiphenylamine | 360 - 390 | 3 | 7.04E+06 | No |
| Pentachlorophenol | 1,700 - 1,900 | 3 | 202,777 | No |
| Phenanthrene | 360 - 390 | 3 | N/A | UT |
| Phenol | 360 - 390 | 3 | 2.76E+08 | No |
| Pyrene | 360 - 390 | 3 | 2.55E+07 | No |
| Tetrachloroethene | 6 - 6 | 5 | 77,111 | No |
| trans-1,3-Dichloropropene | 6 - 6 | 5 | 239,434 | No |
| Trichloroethene | 6 - 6 | 5 | 20,354 | No |
| Vinyl acetate | 11 - 12 | 5 | 3.04E+07 | No |
| Vinyl Chloride | 11 - 12 | 5 | 24,948 | No |

^a No analytes detected in less than 5 percent of samples.

^b Value is the maximum reported result for nondetected analytes.

N/A = Not Available.

UT = Uncertain toxicity.

Table A1.3

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Soil^a

| Analyte | Range of Reported Results | Total Number of Results | Lowest ESL | Maximum Reported Result > ESL? ^b |
|-----------------------------------|---------------------------|-------------------------|-------------|---|
| Inorganics (mg/kg) | | | | |
| Thallium | 0.21 - 1.1 | 19 | 1.00 | Yes |
| Tin | 0.86 - 22.4 | 18 | 2.90 | Yes |
| Organics (ug/kg) | | | | |
| 1,2,4-Trichlorobenzene | 710 | 1 | 777 | No |
| 1,2-Dichlorobenzene | 710 | 1 | N/A | UT |
| 1,3-Dichlorobenzene | 710 | 1 | N/A | UT |
| 1,4-Dichlorobenzene | 710 | 1 | 20,000 | No |
| 2,4,5-Trichlorophenol | 3,600 | 1 | 4,000 | No |
| 2,4,6-Trichlorophenol | 710 | 1 | 161 | Yes |
| 2,4-Dichlorophenol | 710 | 1 | 2,744 | No |
| 2,4-Dimethylphenol | 710 | 1 | N/A | UT |
| 2,4-Dinitrophenol | 3,600 | 1 | 20,000 | No |
| 2,4-Dinitrotoluene | 710 | 1 | 32.1 | Yes |
| 2,6-Dinitrotoluene | 710 | 1 | 6,186 | No |
| 2-Chloronaphthalene | 710 | 1 | N/A | UT |
| 2-Chlorophenol | 710 | 1 | 281 | Yes |
| 2-Methylnaphthalene | 710 | 1 | 2,769 | No |
| 2-Methylphenol | 710 | 1 | 123,842 | No |
| 2-Nitroaniline | 3,600 | 1 | 5,659 | No |
| 2-Nitrophenol | 710 | 1 | N/A | UT |
| 3,3'-Dichlorobenzidine | 1,400 | 1 | N/A | UT |
| 3-Nitroaniline | 3,600 | 1 | N/A | UT |
| 4,4'-DDD | 35 | 1 | 13,726 | No |
| 4,4'-DDE | 35 | 1 | 7.95 | Yes |
| 4,4'-DDT | 35 | 1 | 1.20 | Yes |
| 4,6-Dinitro-2-methylphenol | 3,600 | 1 | 560 | Yes |
| 4-Bromophenyl-phenylether | 710 | 1 | N/A | UT |
| 4-Chloro-3-methylphenol | 710 | 1 | N/A | UT |
| 4-Chloroaniline | 710 | 1 | 716 | No |
| 4-Chlorophenyl-phenyl ether | 710 | 1 | N/A | UT |
| 4-Methylphenol | 710 | 1 | N/A | UT |
| 4-Nitroaniline | 3,600 | 1 | 41,050 | No |
| 4-Nitrophenol | 3,600 | 1 | 7,000 | No |
| Acenaphthene | 710 | 1 | 20,000 | No |
| Acenaphthylene | 710 | 1 | N/A | UT |
| Aldrin | 17 | 1 | 47.0 | No |
| alpha-BHC | 17 | 1 | 18,662 | No |
| alpha-Chlordane | 170 | 1 | 289 | No |
| Anthracene | 710 | 1 | N/A | UT |
| Benzo(a)anthracene | 710 | 1 | N/A | UT |
| Benzo(a)pyrene | 710 | 1 | 631 | Yes |
| Benzo(b)fluoranthene | 710 | 1 | N/A | UT |
| Benzo(g,h,i)perylene | 710 | 1 | N/A | UT |
| Benzo(k)fluoranthene | 710 | 1 | N/A | UT |
| Benzoic Acid | 3,600 | 1 | N/A | UT |
| Benzyl Alcohol | 710 | 1 | 4,403 | No |
| beta-BHC | 17 | 1 | 207 | No |
| bis(2-Chloroethoxy)methane | 710 | 1 | N/A | UT |
| bis(2-Chloroethyl)ether | 710 | 1 | N/A | UT |

Table A1.3

**Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection
Frequency less than 5 Percent in Surface Soil^a**

| Analyte | Range of Reported Results | Total Number of Results | Lowest ESL | Maximum Reported Result > ESL ^b |
|-----------------------------|---------------------------|-------------------------|-------------|--|
| bis(2-Chloroisopropyl)ether | 710 | 1 | N/A | UT |
| bis(2-Ethylhexyl)phthalate | 710 | 1 | 137 | Yes |
| Butylbenzylphthalate | 710 | 1 | 24,155 | No |
| Chrysene | 710 | 1 | N/A | UT |
| delta-BHC | 17 | 1 | 25.9 | No |
| Dibenz(a,h)anthracene | 710 | 1 | N/A | UT |
| Dibenzofuran | 710 | 1 | 21,200 | No |
| Dieldrin | 35 | 1 | 7.40 | Yes |
| Diethylphthalate | 710 | 1 | 100,000 | No |
| Dimethylphthalate | 710 | 1 | 200,000 | No |
| Di-n-butylphthalate | 710 | 1 | 15.9 | Yes |
| Di-n-octylphthalate | 710 | 1 | 731,367 | No |
| Endosulfan I | 17 | 1 | 80.1 | No |
| Endosulfan II | 35 | 1 | 80.1 | No |
| Endosulfan sulfate | 35 | 1 | 80.1 | No |
| Endrin | 35 | 1 | 1.40 | Yes |
| Endrin ketone | 35 | 1 | 1.40 | Yes |
| Fluoranthene | 710 | 1 | N/A | UT |
| Fluorene | 710 | 1 | 30,000 | No |
| gamma-BHC (Lindane) | 17 | 1 | 25.9 | No |
| gamma-Chlordane | 170 | 1 | 289 | No |
| Heptachlor | 17 | 1 | 63.3 | No |
| Heptachlor epoxide | 17 | 1 | 64.0 | No |
| Hexachlorobenzene | 710 | 1 | 7.73 | Yes |
| Hexachlorobutadiene | 710 | 1 | 431 | Yes |
| Hexachlorocyclopentadiene | 710 | 1 | 5,518 | No |
| Hexachloroethane | 710 | 1 | 366 | Yes |
| Indeno(1,2,3-cd)pyrene | 710 | 1 | N/A | UT |
| Isophorone | 710 | 1 | N/A | UT |
| Methoxychlor | 170 | 1 | 1,226 | No |
| Naphthalene | 710 | 1 | 27,048 | No |
| Nitrobenzene | 710 | 1 | 40,000 | No |
| N-Nitroso-di-n-propylamine | 710 | 1 | N/A | UT |
| N-Nitrosodiphenylamine | 710 | 1 | 20,000 | No |
| PCB-1016 | 170 | 1 | 42.3 | Yes |
| PCB-1221 | 170 | 1 | 42.3 | Yes |
| PCB-1232 | 170 | 1 | 42.3 | Yes |
| PCB-1242 | 170 | 1 | 42.3 | Yes |
| PCB-1248 | 170 | 1 | 42.3 | Yes |
| PCB-1254 | 350 | 1 | 42.3 | Yes |
| PCB-1260 | 350 | 1 | 42.3 | Yes |
| Pentachlorophenol | 3,600 | 1 | 122 | Yes |
| Phenanthrene | 710 | 1 | N/A | UT |
| Phenol | 710 | 1 | 23,090 | No |
| Pyrene | 710 | 1 | N/A | UT |
| Toxaphene | 350 | 1 | 3,756 | No |

^a No analytes detected in less than 5 percent of samples.

^b Value is the maximum reported result for nondetected analytes.

N/A = Not Available.

UT = Uncertain toxicity.

BOLD = Maximum reported result greater than the ESL.

Table A1.4
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection
Frequency less than 5 Percent in Subsurface Soil^a

| Analyte | Range of Reported Results | Total Number of Results | Lowest ESL | Maximum Reported Results > ESL ^b |
|-----------------------------|---------------------------|-------------------------|------------|---|
| Inorganics (mg/kg) | | | | |
| Antimony | 9.5 - 9.7 | 2 | 18.7 | No |
| Mercury | 0.06 - 0.11 | 6 | 3.15 | No |
| Silver | 0.34 - 1.2 | 6 | N/A | UT |
| Thallium | 0.22 - 0.39 | 6 | 204 | No |
| Tin | 2.9 - 31.4 | 5 | 80.6 | No |
| Organics (ug/kg) | | | | |
| 1,1,2,2-Tetrachloroethane | 6 - 6 | 5 | 4.70E+06 | No |
| 1,1,2-Trichloroethane | 6 - 6 | 5 | N/A | UT |
| 1,1-Dichloroethane | 6 - 6 | 5 | 215,360 | No |
| 1,1-Dichloroethene | 6 - 6 | 5 | 1.28E+06 | No |
| 1,2,4-Trichlorobenzene | 360 - 390 | 3 | 94,484 | No |
| 1,2-Dichlorobenzene | 360 - 390 | 3 | N/A | UT |
| 1,2-Dichloroethane | 6 - 6 | 5 | 2.00E+06 | No |
| 1,2-Dichloroethene | 6 - 6 | 5 | 1.87E+06 | No |
| 1,2-Dichloropropane | 6 - 6 | 5 | 3.92E+06 | No |
| 1,3-Dichlorobenzene | 360 - 390 | 3 | N/A | UT |
| 1,4-Dichlorobenzene | 360 - 390 | 3 | 5.93E+06 | No |
| 2,4,5-Trichlorophenol | 1,700 - 1,900 | 3 | N/A | UT |
| 2,4,6-Trichlorophenol | 360 - 390 | 3 | 17,263 | No |
| 2,4-Dichlorophenol | 360 - 390 | 3 | 249,324 | No |
| 2,4-Dimethylphenol | 360 - 390 | 3 | N/A | UT |
| 2,4-Dinitrophenol | 1,700 - 1,900 | 3 | 4.90E+06 | No |
| 2,4-Dinitrotoluene | 360 - 390 | 3 | 2,473 | No |
| 2,6-Dinitrotoluene | 360 - 390 | 3 | 477,309 | No |
| 2-Butanone | 11 - 12 | 5 | 4.94E+07 | No |
| 2-Chloronaphthalene | 360 - 390 | 3 | N/A | UT |
| 2-Chlorophenol | 360 - 390 | 3 | 21,598 | No |
| 2-Hexanone | 11 - 12 | 5 | N/A | UT |
| 2-Methylnaphthalene | 360 - 390 | 3 | 319,121 | No |
| 2-Methylphenol | 360 - 390 | 3 | 9.26E+06 | No |
| 2-Nitroaniline | 1,700 - 1,900 | 3 | 418,475 | No |
| 2-Nitrophenol | 360 - 390 | 3 | N/A | UT |
| 3,3'-Dichlorobenzidine | 710 - 780 | 3 | N/A | UT |
| 3-Nitroaniline | 1,700 - 1,900 | 3 | N/A | UT |
| 4,6-Dinitro-2-methylphenol | 1,700 - 1,900 | 3 | 44,283 | No |
| 4-Bromophenyl-phenylether | 360 - 390 | 3 | N/A | UT |
| 4-Chloro-3-methylphenol | 360 - 390 | 3 | N/A | UT |
| 4-Chloroaniline | 360 - 390 | 3 | 48,856 | No |
| 4-Chlorophenyl-phenyl ether | 360 - 390 | 3 | N/A | UT |
| 4-Methyl-2-pentanone | 11 - 12 | 5 | 859,131 | No |
| 4-Methylphenol | 360 - 390 | 3 | N/A | UT |
| 4-Nitrophenol | 1,700 - 1,900 | 3 | 1.02E+06 | No |
| 4-Nitroaniline | 1,700 - 1,900 | 3 | 2.62E+06 | No |
| Acenaphthene | 360 - 390 | 3 | N/A | UT |
| Acenaphthylene | 360 - 390 | 3 | N/A | UT |
| Acetone | 11 - 12 | 5 | 247,687 | No |
| Anthracene | 360 - 390 | 3 | N/A | UT |
| Benzene | 6 - 6 | 5 | 1.10E+06 | No |
| Benzo(a)anthracene | 360 - 390 | 3 | N/A | UT |
| Benzo(a)pyrene | 360 - 390 | 3 | 502,521 | No |
| Benzo(b)fluoranthene | 360 - 390 | 3 | N/A | UT |

Table A1.4
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection
Frequency less than 5 Percent in Subsurface Soil^a

| Analyte | Range of Reported Results | Total Number of Results | Lowest ESL | Maximum Reported Results > ESL ^b |
|-----------------------------|---------------------------|-------------------------|------------|---|
| Benzo(g,h,i)perylene | 360 - 390 | 3 | N/A | UT |
| Benzo(k)fluoranthene | 360 - 390 | 3 | N/A | UT |
| Benzoic Acid | 1,700 - 1,900 | 3 | N/A | UT |
| Benzyl Alcohol | 360 - 390 | 3 | 253,015 | No |
| bis(2-Chloroethoxy)methane | 360 - 390 | 3 | N/A | UT |
| bis(2-Chloroethyl)ether | 360 - 390 | 3 | N/A | UT |
| bis(2-Chloroisopropyl)ether | 360 - 390 | 3 | N/A | UT |
| Bromodichloromethane | 6 - 6 | 5 | 381,135 | No |
| Bromoform | 6 - 6 | 5 | 198,571 | No |
| Bromomethane | 11 - 12 | 5 | N/A | UT |
| Butylbenzylphthalate | 360 - 390 | 3 | 3.37E+06 | No |
| Carbon Disulfide | 6 - 6 | 5 | 410,941 | No |
| Carbon Tetrachloride | 6 - 6 | 5 | 736,154 | No |
| Chlorobenzene | 6 - 6 | 5 | 413,812 | No |
| Chloroethane | 11 - 12 | 5 | N/A | UT |
| Chloroform | 6 - 6 | 5 | 560,030 | No |
| Chloromethane | 11 - 12 | 5 | N/A | UT |
| Chrysene | 360 - 390 | 3 | N/A | UT |
| cis-1,3-Dichloropropene | 6 - 6 | 5 | 222,413 | No |
| Dibenz(a,h)anthracene | 360 - 390 | 3 | N/A | UT |
| Dibenzofuran | 360 - 390 | 3 | 2.44E+06 | No |
| Dibromochloromethane | 6 - 6 | 5 | 389,064 | No |
| Diethylphthalate | 360 - 390 | 3 | 2.21E+08 | No |
| Dimethylphthalate | 360 - 390 | 3 | 1.35E+07 | No |
| Di-n-butylphthalate | 360 - 390 | 3 | 4.06E+07 | No |
| Di-n-octylphthalate | 360 - 390 | 3 | 2.58E+08 | No |
| Ethylbenzene | 6 - 6 | 5 | N/A | UT |
| Fluoranthene | 360 - 390 | 3 | N/A | UT |
| Fluorene | 360 - 390 | 3 | N/A | UT |
| Hexachlorobenzene | 360 - 390 | 3 | 190,142 | No |
| Hexachlorobutadiene | 360 - 390 | 3 | 150,894 | No |
| Hexachlorocyclopentadiene | 360 - 390 | 3 | 799,679 | No |
| Hexachloroethane | 360 - 390 | 3 | 45,656 | No |
| Indeno(1,2,3-cd)pyrene | 360 - 390 | 3 | N/A | UT |
| Isophorone | 360 - 390 | 3 | N/A | UT |
| Methylene Chloride | 6 - 6 | 5 | 209,560 | No |
| Naphthalene | 360 - 390 | 3 | 1.60E+07 | No |
| Nitrobenzene | 360 - 390 | 3 | N/A | UT |
| N-Nitroso-di-n-propylamine | 360 - 390 | 3 | N/A | UT |
| N-Nitrosodiphenylamine | 360 - 390 | 3 | 2.15E+06 | No |
| Pentachlorophenol | 1,700 - 1,900 | 3 | 18,373 | No |
| Phenanthrene | 360 - 390 | 3 | N/A | UT |
| Phenol | 360 - 390 | 3 | 1.49E+06 | No |
| Pyrene | 360 - 390 | 3 | N/A | UT |
| Tetrachloroethene | 6 - 6 | 5 | 72,494 | No |
| trans-1,3-Dichloropropene | 6 - 6 | 5 | 222,413 | No |
| Trichloroethene | 6 - 6 | 5 | 32,424 | No |
| Vinyl acetate | 11 - 12 | 5 | 730,903 | No |
| Vinyl Chloride | 11 - 12 | 5 | 6,494 | No |

^a No analytes detected in less than 5 percent of samples.

^b Value is the maximum reported result for nondetected analytes.

N/A = Not Available.

UT = Uncertain toxicity.

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COMPREHENSIVE RISK ASSESSMENT

SOUTHEAST BUFFER ZONE AREA EXPOSURE UNIT

VOLUME 13: ATTACHMENT 2

Data Quality Assessment

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ACRONYMS AND ABBREVIATIONS

| | |
|------|--------------------------------------|
| AA | atomic absorption |
| AI | adequate intake |
| ASD | Analytical Services Division |
| COC | contaminant of concern |
| CRA | Comprehensive Risk Assessment |
| CRDL | contract required detection limit |
| DER | duplicate error ratio |
| DQA | Data Quality Assessment |
| DQO | data quality objective |
| DRC | data review checklist |
| EDD | electronic data deliverable |
| EPA | U.S. Environmental Protection Agency |
| EPC | exposure point concentration |
| EU | Exposure Unit |
| IAG | Interagency Agreement |
| ICP | inductively couple plasma |
| IDL | instrument detection limit |
| LCS | laboratory control sample |
| MDA | minimum detectable activity |
| MDL | method detection limit |
| MS | matrix spike |
| MSA | method of standard additions |
| MSD | matrix spike duplicate |

| | |
|-------|--|
| NIST | National Institute of Standards Technology |
| PARCC | precision, accuracy, representativeness, completeness, and comparability |
| PPT | Pipette |
| PCB | polychlorinated biphenyl |
| QC | quality control |
| RDL | required detection limit |
| RFEDS | Rocky Flats Environmental Data System |
| RFETS | Rocky Flats Environmental Technology Site |
| RI/FS | Remedial Investigation/Feasibility Study |
| RL | reporting limit |
| RPD | relative percent difference |
| SEEU | Southeast Buffer Zone Exposure Unit |
| SDP | standard data package |
| SOW | Statement of Work |
| SVOC | semi-volatile organic compound |
| SWD | Soil Water Database |
| TCLP | Toxicity Characteristic Leaching Procedure |
| TIC | tentatively identified compound |
| V&V | verification and validation |
| VOC | volatile organic compound |

EXECUTIVE SUMMARY

This document provides an assessment of the quality of the data used in the Southeast Buffer Zone (BZ) Area Exposure Unit (EU) (SEEU) Comprehensive Risk Assessment (CRA). This Data Quality Assessment (DQA) focuses on all elements of quality control (QC) including both laboratory and sample-specific QC data.

Depending on the matrix and analyte group, anywhere from 83 to 100 percent of the SEEU data have been verified and/or validated by a validator from the Analytical Services Division (ASD) at the Rocky Flats Environmental Technology Site (RFETS) (or from an outside subcontractor) using verification and validation (V&V) guidelines for each analytical method developed for RFETS. V&V data are identified in the RFETS Soil Water Database (SWD) by a data qualifier flag and reason code(s) that provide an explanation for the qualifier flag. All rejected data have been removed from the data set used in the CRA because the validator has determined the data are unusable. The remaining V&V data have associated qualifier flags indicating that the data are valid, estimated, or undetected, and are used in the CRA. Of the SEEU V&V data, approximately 15 percent was qualified as estimated and/or undetected. Less than 5 percent of the data reported as detected by the laboratory were qualified as undetected due to blank contamination. Data qualified as estimated or undetected are a result of various minor laboratory noncompliance issues that are insufficient to render the data unusable.

A review of the SEEU V&V data indicates that the data meet the data quality objectives (DQOs) outlined in the Final CRA Work Plan and Methodology (K-H 2004) (hereafter referred to as the CRA Methodology). A review of the most common observations found in the V&V data determined that a minimal amount, less than 1 percent, of the non-V&V data may have been qualified if a review had been performed. Based on this DQA, data for the SEEU are of sufficient quality for use in the CRA

1.0 INTRODUCTION

The Southeast Buffer Zone (BZ) Area Exposure Unit (EU) (SEEU) Comprehensive Risk Assessment (CRA) for the Rocky Flats Environmental Technology Site (RFETS) has been prepared in accordance with the CRA Methodology. The CRA Methodology was developed jointly with the regulatory agencies using the consultative process, and was approved by the agencies on September 28, 2004. Consistent with the CRA Methodology, data quality was assessed using a standard precision, accuracy, representativeness, completeness, and comparability (PARCC) parameter analysis (EPA 2002). Both laboratory and field quality control (QC) were evaluated for the SEEU data set.

Although many of the elements of QC that are reviewed in this document affect more than one PARCC parameter, their major impact on data quality is described below:

- Precision, as a measure of agreement among replicate measurements, is determined quantitatively based on the results of replicate laboratory measurements. Precision of the laboratory data was verified through review of:
 - Relative percent differences (RPDs) for laboratory control samples (LCSs) and LCS duplicates compared to the acceptable ranges (analytical precision);
 - RPDs (nonradionuclides) and duplicate error ratios (DERs) (radionuclides) for field sample and field duplicates compared to the acceptable ranges¹ (field precision);
 - RPDs for matrix spike (MS) and matrix spike duplicates (MSDs) compared to acceptable control ranges (matrix precision); and
 - RPDs for primary- and second-column analyses (analytical precision).
- Accuracy, as a measure of the distortion of a measurement process that causes error in measuring the true value, is determined quantitatively based on the analysis of samples with a known concentration. Accuracy of the laboratory data was verified through review of:
 - LCS data, calibration verification data, internal standard data, and instrument tune parameters (laboratory accuracy); and
 - Surrogate recoveries, MSs, and sample preparation (sample-specific accuracy).
- Representativeness of the data was verified through review of:

¹ The CRA Methodology states that the overall precision of the data is considered adequate if the RPD between the target and duplicate, at concentrations five times the reporting limit (RL), is less than 35 percent for solids and 20 percent for liquids. The precision adequacy requirement for radiological contaminants is a DER less than 1.96.

- Laboratory blank data;
 - Sample preservation/storage;
 - Adherence to sample holding times;
 - Documentation issues;
 - Contract noncompliance issues; and
 - Laboratory activities affecting ability to properly identify compounds.
- Completeness is a data adequacy criterion and is addressed in Appendix A, Volume 2 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report). It refers to the spatial and temporal distribution of the data, and their adequacy for estimating exposure point concentrations (EPCs) for the CRA.
 - Comparability of the data was verified through evaluation of:
 - Analytical procedures, and whether they were standard U.S. Environmental Protection Agency (EPA)- and RFETS-approved procedures;
 - Instrument types and maintenance, sample preparation techniques, and standard units for reporting; and
 - MS and surrogate samples, ensuring accuracy within acceptable ranges.

2.0 ANALYTICAL DATA

Approximately 7,600 specific analytical records exist in the SEEU CRA data set, some 92 percent of which (6,991 records) have undergone verification and validation (V&V). The fraction of the data that was verified and/or validated is shown in Table A2.1 by analyte group and matrix. These data were reviewed by validators and their observations and comments are captured in the Soil Water Database (SWD). All of the data that have been flagged due to V&V findings (except "R"-flagged data) and data that have no flags as a result of V&V are used in the SEEU CRA. The small amount of data that has not undergone V&V is used as provided by the laboratories. The most common errors found during V&V such as transcription errors, calculation errors, and excluded records that were later added by the validator were reviewed to determine the possible effect on non-V&V data. Assuming that the percentage of data qualified with these issues is representative of the number of observations that would have been made if a review of the non-V&V data had been performed, less than 1 percent of the entire SEEU data set is at risk for such unacknowledged and, therefore, uncorrected errors.

Data V&V involves an in-depth review of the data packages from the laboratory to assess compliance with contract requirements. In general, data validation includes all of the activities of verification, as well as additional QC checks and review of some raw laboratory instrument data and calculations. After V&V, a data qualifier flag and/or reason code(s) are assigned to the data record (Tables A2.2 and A2.3). The reason codes provide an explanation for the qualifier flag, thereby making it possible to determine which of the PARCC parameters is affected by the observation (Table A2.4). Qualifier flags are discussed in this Data Quality Assessment (DQA) as those V&V flags that note issues in the data. V&V flags "V," "V1," and "1" represent data that were reviewed by validators, but no issues were observed. Eighty-one percent of the V&V data fall into this category. Additional qualifier flags such as "A," "E," and "Z" were also applied. These validation qualifiers are notations that do not indicate estimation or a change in the status of detection. The data are valid and useable as reported by the laboratory. Four percent of the V&V data are represented by these additional qualifier flags. The specific definitions of these additional V&V flags are presented in Table A2.2. Data with noted issues are presented in Table A2.5 and discussed in detail in Section 3.0.

V&V qualifier flags are not specifically addressed in this data assessment, but rather the reason codes associated with the qualifier flags for each analytical record are summarized and evaluated. This approach was chosen because the validator's specific observations (reason codes), and not the qualifier flags, provide the best descriptors of the data quality.

V&V data records contain a field with V&V reason codes (5, 18/52, 200, 99/101/701, and so forth), or the field is null. These reason codes represent observations related to assessment of precision, accuracy, and representativeness. For example, the reason code 110 definition (see Table A2.3) is "LCS recovery criteria were not met," which is an observation related to data accuracy.

Multiple reason codes were routinely applied to a specific sample method/matrix/analyte combination. Therefore, it was necessary to parse out the individual codes to create a table that included a unique record identifier and the associated parsed data V&V reason code (5, 18, 52, 200, 99, 101, 701, and so forth). With this information and the data V&V reason code definitions, the data validator's observations related to this data set can be re-created for each analytical record.

To summarize the reason codes in a logical manner for presentation, it was first necessary to group the reason codes that have slightly different definitions but convey the same meaning. A standardized definition was then applied to the individual reason codes within the group. The grouped reason codes were also assigned a QC category (for example, blanks, calibration, and holding time), and the affected PARCC parameter (Table A2.4). The reason codes were then summarized for each medium and analyte group within each QC category, applying the standardized definition to the summarized codes. The summary is presented in Table A2.5.

Rejected data (data qualifier flag "R"), consisting of approximately 3 percent of all V&V data, have been removed from the data used in the SEEU CRA because the validator has

determined the data to be unusable. The fraction of the data that was rejected during validation and/or verification is shown in Table A2.6 by analyte group and matrix.

Finally, evaluating the RPD (DER for radionuclides) between a target sample and the associated field duplicate is not a QC parameter performed during V&V, but is still an important analysis when determining data precision. Because this analysis was not performed during V&V, the target sample/field duplicate RPD and DER calculations were performed separately and are presented in Table A2.7 as the number of exceedances per analyte group/matrix combination. Only those analyte group/matrix combinations having records that met the criteria for calculating an RPD or DER are presented. RPDs and DERs for target sample/field duplicate analyte pairs where one or both of the results are less than five times the RL are not calculated as outlined in the CRA Methodology.

3.0 FINDINGS

V&V observations affecting the CRA data set are summarized by analyte group/matrix/QC category/V&V observation in Table A2.5. The detected and nondetected results are summarized separately to give the reader a better idea of the impact on data usability. Only those issues observed in notable percentages (generally greater than 5 percent) of the data are discussed below in further detail. RPDs (DERs for radionuclides) presented in Table A2.7 are only discussed below when RPD (DER for radionuclides) exceedances of control criteria are greater than 10 percent for any given analyte group/matrix combination. Instances of elevated rates (greater than 10 percent) of rejected data are also discussed below.

3.1 Dioxins and Furans – Water

Documentation issues resulted in data V&V qualifications related to this analyte group/matrix combination. Although 100 percent of the data were qualified, this was only one record. In addition, validator-added records have no impact on data quality because all issues have previously been evaluated and corrected.

3.2 Herbicides – Water

Calibration resulted in data V&V qualifications related to this analyte group/matrix combination. While the percentage of all qualifications is elevated, it is important to note that all data were qualified as usable, although estimated.

3.3 Metals – Soil

Blank, calibration, documentation, holding time, instrument setup, LCS, matrix, and other observations resulted in data V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified due to matrix issues and expired instrument detection limit (IDL) studies. While the importance of these QC parameters should not be overlooked, it is also

important to note that the data were qualified as usable, although estimated. Finally, a single sample/field duplicate pair resulted in the elevated percentage of field duplicate qualification, this is more indicative of matrix at a particular location, than a overall precision indication.

3.4 Metals – Water

Blank, calibration, documentation, holding time, instrument setup, LCS, matrix, sample preparation, sensitivity, and other observations resulted in V&V qualifications associated with this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified due to blank contamination. While the importance of blank analyses should not be overlooked, it is also important to note that the data were qualified as usable.

3.5 Polychlorinated Biphenyls (PCBs) – Water

Documentation and surrogate issues resulted in elevated data V&V observations related to this analyte group/matrix combination. All transcription errors have previously been evaluated and corrected, and while the importance surrogate analyses should not be overlooked, it is also important to note that the data were qualified as usable, although estimated.

3.6 Pesticides – Water

Calibration, documentation, and surrogate observations resulted in data V&V qualifications related to this analyte group/matrix combination. The percentage of records qualified due to issues with continuing calibration verifications and low surrogate recoveries is high. While the importance of continuing calibration verifications and surrogate analyses should not be overlooked, it is also important to note that the data were qualified as usable, although estimated.

3.7 Radionuclides – Soil

Blank, calibration, documentation, instrument setup, LCS, matrix, sensitivity, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. Insufficient documentation indicates that a complete V&V evaluation may not have been performed, but it is important to note that the data were qualified as usable, although estimated. Transcription errors, validator-added records, and validator-calculated minimum detectable activities (MDAs) have no effect on data quality as all issues have previously been evaluated and corrected. While the importance of blank and other QC analyses including LCSs should not be overlooked, it is important to note that these records were also qualified as usable, although estimated. Finally, although 20 percent of the V&V data for this analyte group/matrix combination was rejected, 96 percent of all associated

data underwent V&V. This leaves less than 1 percent of the data related to this analyte group/matrix combination that may have been rejected if a review had been performed.

3.8 Radionuclides – Water

Blank, calculation error, calibration, documentation, holding time, instrument setup, LCS, matrix, sensitivity, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. Insufficient documentation indicates that a complete V&V evaluation may not have been performed, but it is important to note that the data were qualified as usable, although estimated. Transcription errors and validator-calculated MDAs have no effect on data quality as all issues have previously been evaluated and corrected. While the importance continuing calibration verifications and MS/MSD analyses should not be overlooked, it is important to note that these records were also qualified as usable. Most of those records qualified as directing the data user to the hard copy validation report for further explanation of the observation were also qualified as estimated. The CRA is performed with this uncertainty in mind, and no further effort was made to identify the issues. Finally, although almost 10 percent of the V&V data for this analyte group/matrix combination was rejected, 83 percent of all associated data underwent V&V. This leaves only less than 2 percent of the data for this analyte group/matrix combination that may have been rejected if a review had been performed.

3.9 Semi-Volatile Organic Compounds (SVOCs) – Water

Blank, calibration, documentation, holding time, instrument setup, LCS, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

3.10 Volatile Organic Compounds (VOCs) – Soil

Blank, documentation, and holding time issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified because the allowed sample holding time was exceeded. While the importance of observing allowed sample holding times should not be overlooked, it is important to note that the results were not qualified indicating a gross exceedances of the holding time, as was the practice if appropriate, and the data were qualified as usable, although estimated.

3.11 Volatile Organic Compounds – Water

Blank, calibration, confirmation, documentation, holding time, instrument setup, LCS, and other issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified because the allowed sample holding time was exceeded and because the instrument tune criteria were not met. While the importance of these QC criteria should

not be overlooked, it is also important to note that the data were qualified as usable, although estimated.

3.12 Wet Chemistry Parameters – Soil

Matrix and other issues resulted in V&V observations related to this analyte group/matrix combination. While the percentage of all observations is high, it is important to note that this analyte group contains numerous general chemistry parameters having little or no impact on site characterization.

3.13 Wet Chemistry Parameters – Water

Calibration, documentation, holding time, matrix, and other issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

4.0 CONCLUSIONS

The quality of the laboratory results were evaluated for compliance with the CRA Methodology data quality objectives (DQOs) through an overall review of PARCC parameters.

Of the data used in the SEEU CRA, approximately 92 percent underwent the V&V process. Of that 92 percent, 81 percent was qualified as having no QC issues and approximately 15 percent was qualified as estimated or undetected (Table A2.8). The remaining 4 percent of the V&V data are made up of records qualified with additional flags indicating acceptable data such as “A,” “E,” or “P”. Approximately 5 percent of the data reported as detected by the laboratory were flagged as undetected by the validators due to blank contamination (Table A2.9). Data qualified as estimated or undetected indicate some issues with PARCC parameters, but not to a degree sufficient to mark the data unusable. Approximately 3 percent of the entire data set was rejected during the V&V process (Table A2.6).

Although many of the elements of QC that are reviewed in this document affect more than one PARCC parameter, the general discussion below summarizes the data quality per the validation reason codes affecting each specific PARCC parameter. Several V&V reason codes have no real impact on data quality because they represent issues that were noted but corrected, or represent observations related to missing documentation that was not required for data assessment. Approximately 12 percent of the SEEU V&V data were flagged with these “Other” V&V observations.

- Precision, as a measure of agreement among replicate measurements, is determined quantitatively based on the results of replicate laboratory measurements.

Of the V&V data, approximately 2 percent was noted for observations related to precision. Of that 2 percent, 95 percent was qualified for issues related to sample matrices and the remaining 5 percent was qualified for issues related to result confirmation. No LCS or instrument setup or sensitivity issues related to precision were noted.

RPDs and DERs for target sample/field duplicate pairs were found to be acceptable for all analyte group/matrix combinations. Overall, the method precision was found to be generally acceptable.

- Accuracy is a measure of the distortion of a measurement process that causes error in the true value.

Of the V&V data, 42 percent was noted for accuracy-related observations. Of that 42 percent, 78 percent was noted for laboratory practice-related observations, while sample-specific accuracy observations make up the other 22 percent. Although the percentage of data with noted accuracy issues is slightly elevated, it is important to note that the majority of the data qualified for these accuracy-related observations are flagged as estimated and the CRA is performed with this uncertainty in mind.

Accuracy was generally acceptable with infrequent performance outside QC limits.

- Representativeness of the data was verified.

Of the V&V data, approximately 40 percent was noted for observations related to representativeness. Of that 40 percent, 68 percent was qualified for blank observations, 23 percent for failure to observe allowed holding times, 2 percent for sensitivity issues, and 3 percent for documentation issues. Instrument setup, LCS, matrix, sample preparation, and other observations make up the other 4 percent of the data qualified for observations related to sample representativeness.

Reportable levels of target analytes were not routinely detected in the laboratory blanks greater than the laboratory RLs except for relatively isolated incidences. Samples were generally stored and preserved properly. Overall, these elements of QC exceedances are indicative of normal laboratory operations and have little impact the sample data as reported.

Sample data are representative of the site conditions at the time of sample collection.

- Comparability of the data was reviewed and no systematic errors were noted.
 - The use of standard EPA- and RFETS-approved analytical procedures;
 - Instrument types and maintenance, sample preparation techniques, and standard units for reporting; and

- Evaluation of MS and surrogate samples, ensuring accuracy within acceptable ranges.

Examination of these parameters did not show any systematic issues with comparability.

- Completeness, as defined in the CRA Methodology, is addressed in Appendix A, Volume 2 of the RI/FS Report.

Another indication of completeness that is sometimes used is a measure of the number of valid measurements obtained in relation to the total number of measurements planned.

Because only 3 percent of the overall data were rejected, the use of non-V&V data for the SEEU CRA does not contribute to any completeness issues.

This review concludes that the PARCC of the data are generally acceptable and the CRA objectives have been met.

5.0 REFERENCES

K-H, 2004. Final Comprehensive Risk Assessment Work Plan and Methodology, Environmental Restoration, Rocky Flats Environmental Technology Site, Golden, Colorado. September.

EPA, 2002. Guidance for Quality Assurance Project Plans. EPA QA/G-5, EPA/240/R-02/009. Office of Environmental Information, Washington, D.C. December.

TABLES

Table A2.1
CRA Data V&V Summary

| Analyte Group | Matrix | Total No. of V&V Records | Total No. of CRA Records | Percent V&V (%) |
|--------------------|--------|--------------------------|--------------------------|-----------------|
| Dioxins and Furans | WATER | 1 | 1 | 100.00 |
| Herbicide | SOIL | 4 | 4 | 100.00 |
| Herbicide | WATER | 7 | 7 | 100.00 |
| Metal | SOIL | 831 | 831 | 100.00 |
| Metal | WATER | 1,647 | 1,857 | 88.69 |
| PCB | SOIL | 7 | 7 | 100.00 |
| PCB | WATER | 35 | 35 | 100.00 |
| Pesticide | SOIL | 24 | 24 | 100.00 |
| Pesticide | WATER | 115 | 115 | 100.00 |
| Radionuclide | SOIL | 291 | 303 | 96.04 |
| Radionuclide | WATER | 395 | 477 | 82.81 |
| SVOC | SOIL | 236 | 236 | 100.00 |
| SVOC | WATER | 308 | 330 | 93.33 |
| VOC | SOIL | 186 | 186 | 100.00 |
| VOC | WATER | 2,629 | 2,878 | 91.35 |
| Wet Chemistry | SOIL | 18 | 18 | 100.00 |
| Wet Chemistry | WATER | 257 | 287 | 89.55 |
| Total | | 6,991 | 7,596 | 92.04% |

Table A2.2
V&V Qualifier Flag Definitions

| Validation Qualifier Code | Description |
|---------------------------|---|
| I | QC data from a data package – Verification |
| A | Data acceptable with qualifications |
| B | Compound was found in BLK and sample |
| C | Calibration |
| E | Associated value exceeds calibration range; dilute and reanalyze |
| J | Estimated quantity – Validation |
| J1 | Estimated quantity – Verification |
| JB | Organic method blank contamination – Validation |
| JB1 | Organic method blank contamination – Verification |
| N | Historical – Validators asked not to validate this |
| NJ | Associated value is presumptively estimated |
| NJ1 | Value presumptively estimated – Verification |
| P | Systematic error |
| R | Data unusable – Validation |
| R1 | Data unusable – Verification |
| S | Matrix spike |
| U | Analyzed, not detected at/above method detection limit |
| U1 | Analyzed, not detect at/above method detection limit – Verification |
| UJ | Associated value is considered estimated at an elevated detection |
| UJ1 | Estimated at elevated level – Verification |
| V | No problems with the data – Validation |
| V1 | No problems with the data – Verification |
| Y | Analytical results in validation process |
| Z | Validation was not requested or could not be performed |

Table A2.3
V&V Reason Code Definitions

| Validation Reason Code | Description |
|------------------------|--|
| *** | Unknown code from RFEDS |
| 1 | Holding times were exceeded |
| 2 | Holding times were grossly exceeded |
| 3 | Initial calibration correlation coefficient <0.995 |
| 4 | Calibration verification criteria were not met |
| 5 | CRDL check sample recovery criteria were not met |
| 6 | Incorrect calibration of instrument |
| 7 | Analyte values > IDL were found in the blanks |
| 8 | Negative bias was indicated in the blanks |
| 9 | Interference indicated in the ICP interference check sample |
| 10 | Laboratory control sample recovery criteria were not met |
| 11 | Duplicate sample precision criteria were not met |
| 12 | Predigestion matrix spike criteria were not met (+/- 25 percent) |
| 13 | Predigestion matrix spike criteria were not met (<30 percent) |
| 14 | Post-digestion matrix spike recovery criteria were not met |
| 15 | MSA was required but not performed |
| 16 | MSA calibration correlation coefficient <0.995 |
| 17 | Serial dilution criteria not met |
| 18 | Documentation was not provided |
| 19 | Calibration verification criteria not met |
| 20 | AA duplicate injection precision criteria were not met |
| 21 | Reagent blanks exceeded MDA |
| 22 | Tracer contamination |
| 23 | Improper aliquot size |
| 24 | Sample aliquot not taken quantitatively |
| 25 | Primary standard had exceeded expiration date |
| 26 | No raw data submitted by the laboratory |
| 27 | Recovery criteria were not met |
| 28 | Duplicate analysis was not performed |
| 29 | Verification criteria were not met |
| 30 | Replicate precision criteria were not met |
| 31 | Replicate analysis was not performed |
| 32 | Laboratory control samples >+/- 3 sigma |
| 33 | Laboratory control samples >+/- 2 sigma and <+/- 3 sigma |
| 35 | Transformed spectral index external ST criteria were not met |
| 36 | MDA exceeded the RDL |
| 37 | Sample exceeded efficiency curve weight limit |
| 38 | Excessive solids on planchet |
| 39 | Tune criteria not met |
| 40 | Organics initial calibration criteria were not met |
| 41 | Organics continuing calibration criteria were not met |
| 42 | Surrogates were outside criteria |
| 43 | Internal standards outside criteria |
| 44 | No mass spectra were provided |
| 45 | Results were not confirmed |
| 47 | Percent breakdown exceeded 20 percent |
| 48 | Linear range of instrument was exceeded |

**Table A2.3
V&V Reason Code Definitions**

| Validation Reason Code | Description |
|-------------------------------|---|
| 49 | Method blank contamination |
| 51 | Nonverifiable laboratory results and/or unsubmitted data |
| 52 | Transcription error |
| 53 | Calculation error |
| 54 | Incorrect reported activity or MDA |
| 55 | Result exceeds linear range; serial dilution value reported |
| 56 | IDL changed due to significant figure discrepancy |
| 57 | Percent solids < 30 percent |
| 58 | Percent solids < 10 percent |
| 59 | Blank activity exceeded RDL |
| 60 | Blank recovery criteria were not met |
| 61 | Replicate recovery criteria were not met |
| 62 | LCS relative percent error criteria not met |
| 63 | LCS expected value not submitted/verifiable |
| 64 | Nontraceable/noncertified standard was used |
| 67 | Sample results not submitted/verifiable |
| 68 | Frequency of quality control samples not met |
| 69 | Samples not distilled |
| 70 | Resolution criteria not met |
| 71 | Unit conversion of results |
| 72 | Calibration counting statistics not met |
| 73 | Daily instrument performance assessment not performed |
| 74 | LCS data not submitted |
| 75 | Blank data not submitted |
| 76 | Instrument gain and/or efficiency not submitted |
| 77 | Detector efficiency criteria not met |
| 78 | MDAs were calculated by reviewer |
| 79 | Result obtained through dilution |
| 80 | Spurious counts of unknown origin |
| 81 | Repeat count outside of 3 sigma counting error |
| 82 | Sample results were not corrected for decay |
| 83 | Sample results were not included on Data Summary Table |
| 84 | Key fields wrong |
| 85 | Record added by QLI |
| 86 | Results considered qualitative not quantitative |
| 87 | Laboratory did no analysis for this record |
| 88 | Blank corrected results |
| 89 | Sample analysis was not requested |
| 90 | Sample result was not validated due to reanalysis |
| 91 | Unit conversion; QC sample activity/uncertainty/MDA |
| 99 | See hard copy for further explanation |
| 101 | Holding times were exceeded (attributed to laboratory problem) |
| 102 | Holding times were grossly exceeded (attribute to laboratory problem) |
| 103 | Calibration correlation coefficient does not meet requirement |
| 104 | Calibration verification recovery criteria were not met |
| 105 | Low-level check sample recovery criteria were not met |
| 106 | Calibration did not contain minimum number of standards |

Table A2.3
V&V Reason Code Definitions

| Validation Reason Code | Description |
|-------------------------------|--|
| 107 | Analyte detected but < RDL in calibration blank verification |
| 109 | Interference indicated in the ICP interference check sample |
| 110 | Laboratory control sample recovery criteria were not met |
| 111 | Laboratory duplicate sample precision criteria were not met |
| 112 | Predigestion matrix spike criteria were not met (+/- 25 percent) |
| 113 | Predigestion matrix spike recovery is <30 percent |
| 114 | Post-digestion matrix spike criteria were not met |
| 115 | MSA was required but not performed |
| 116 | MSA calibration correlation coefficient <0.995 |
| 117 | Serial dilution percent D criteria not met |
| 123 | Improper aliquot size |
| 128 | Laboratory duplicate was not analyzed |
| 129 | Verification criteria for frequency or sequence were not met |
| 130 | Replicate precision criteria were not met |
| 131 | Confirmation percent difference criteria not met |
| 132 | Laboratory control samples >+/- 3 sigma |
| 136 | MDA exceeded the RDL |
| 139 | Tune criteria not met |
| 140 | Requirements for independent calibration verification were not met |
| 141 | Continuing calibration verification criteria were not met |
| 142 | Surrogates were outside criteria |
| 143 | Internal standards outside criteria |
| 145 | Results were not confirmed |
| 147 | Percent breakdown exceeded 20 percent |
| 148 | Linear range of measurement system was exceeded |
| 149 | Method, preparation, or reagent blank contamination > RDL |
| 150 | Unknown carrier volume |
| 152 | Reported data do not agree with raw data |
| 153 | Calculation error |
| 155 | Original result exceeds linear range; serial dilution value reported |
| 159 | Magnitude of calibration verification blank result exceeded the RDL |
| 164 | Standard traceability or certification requirements not met |
| 166 | Carrier aliquot nonverifiable |
| 168 | QC sample frequency does not meet requirements |
| 170 | Resolution criteria not met |
| 172 | Calibration counting statistics not met |
| 174 | LCS data not submitted |
| 175 | Blank data not submitted |
| 177 | Detector efficiency criteria not met |
| 188 | Blank corrected results |
| 199 | See hard copy for further explanation |
| 201 | Preservation requirements not met by the laboratory |
| 205 | Unobtainable omissions or errors on SDP (required for databases) |
| 206 | Analyses were not requested according to the SOW |
| 207 | Sample pretreatment or sample preparation method is incorrect |
| 211 | Poor cleanup recovery |
| 212 | Instrument detection limit was not provided |

Table A2.3
V&V Reason Code Definitions

| Validation Reason Code | Description |
|-------------------------------|--|
| 213 | Instrument detection limit is > the associated RDL |
| 214 | IDL is older than 3 months from date of analysis |
| 215 | Blank results were not reported to the IDL/MDL |
| 216 | Post-digestion spike recoveries outside of 85-115 percent criteria |
| 217 | Post-digestion spike recoveries were < 10 percent |
| 218 | Sample COC was not verifiable (attributed to laboratory) |
| 219 | Standards have expired or are not valid |
| 220 | TCLP sample percent solids < 0.5 percent |
| 222 | TCLP particle size was not performed |
| 224 | Incomplete TCLP extraction data |
| 225 | Insufficient TCLP extraction time |
| 226 | TIC misidentification |
| 227 | No documentation regarding deviations from methods or SOW |
| 228 | Calibration recoveries affecting data quality have not been met |
| 229 | Element not analyzed in ICP interference check sample |
| 230 | QC sample/analyte (e.g., spike, duplicate, LCS) not analyzed |
| 231 | MS/MSD criteria not met |
| 232 | Control limits not assigned correctly |
| 233 | Sample matrix QC does not represent samples analyzed |
| 234 | QC sample does not meet method requirement |
| 235 | Duplicate sample control limits do not pass |
| 236 | LCS control limits do not pass |
| 237 | Preparation blank control limits do not pass |
| 238 | Blank correction was not performed |
| 239 | Winsorized mean plus standard deviation of the same not calculated or calculated wrong |
| 240 | Sample preparations for soil/sludge/sediment were not homog/aliqu properly |
| 241 | No micro PPT or electroplating data available |
| 242 | Tracer requirements were not met |
| 243 | Standard values were not calculated correctly (LCS, tracer, standards) |
| 244 | Standard or tracer is not NIST traceable |
| 245 | Energy calibration criteria not met |
| 246 | Background calibration criteria were not met |
| 247 | Sample or control analysis not chemically separated from each other |
| 248 | Single combined TCLP result was not repeated for sample with both mis+nonm |
| 249 | Result qualified due to blank contamination |
| 250 | Incorrect analysis sequence |
| 251 | Misidentified target compounds |
| 252 | Result is suspect DU |
| 701 | Holding times were exceeded (not attributed to laboratory) |
| 702 | Holding times were grossly exceeded (not attributed to laboratory) |
| 703 | Samples were not preserved properly in the field (not attributed to laboratory) |
| 801 | Missing deliverables (required for data assessment) |
| 802 | Missing deliverables (not required for data assessment) |
| 803 | Omissions or errors on SDP deliverables (required for data assessment) |
| 804 | Omissions or errors on SDP deliverables (not required for data assessment) |
| 805 | Information missing from case narrative |
| 806 | Site samples not used for sample matrix QC |
| 807 | Original documentation not provided |

Table A2.3
V&V Reason Code Definitions

| Validation Reason Code | Description |
|------------------------|--|
| 808 | Incorrect or incomplete DRC |
| 809 | Non-site samples reported with site samples |
| 810 | EDD does not match hard copy; EDD may be resubmitted |

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Table A2.4
Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

| Validation Reason Codes | Standardized Description | QC Category | Affected PARCC Parameter |
|------------------------------|---|----------------------|--------------------------|
| 188, 88 | Blank corrected results | Blanks | Representativeness |
| 238 | Blank correction was not performed | Blanks | Representativeness |
| 175, 75 | Blank data not submitted | Blanks | Representativeness |
| 60 | Blank recovery criteria were not met | Blanks | Representativeness |
| 215 | Blank results were not reported to the IDL/MDL | Blanks | Representativeness |
| 107, 159 | Calibration verification blank contamination | Blanks | Representativeness |
| 149, 21, 237, 249, 49, 59, 7 | Method, preparation, or reagent blank contamination | Blanks | Representativeness |
| 8 | Negative bias indicated in the blanks | Blanks | Representativeness |
| 153, 53 | Calculation error | Calculation Errors | Other |
| 232 | Control limits not assigned correctly | Calculation Errors | Other |
| 246 | Background calibration criteria were not met | Calibration | Accuracy |
| 103, 3 | Calibration correlation coefficient did not meet requirements | Calibration | Accuracy |
| 172, 72 | Calibration counting statistics did not meet criteria | Calibration | Accuracy |
| 106 | Calibration did not contain minimum number of standards | Calibration | Accuracy |
| 228 | Calibration requirements affecting data quality have not been met | Calibration | Accuracy |
| 104, 141, 19, 29, 4, 40, 41 | Continuing calibration verification criteria were not met | Calibration | Accuracy |
| 245 | Energy calibration criteria not met | Calibration | Accuracy |
| 6 | Incorrect calibration of instrument | Calibration | Accuracy |
| 148, 48 | Result exceeded linear range of measurement system | Calibration | Accuracy |
| 155, 55 | Original result exceeded linear range, serial dilution value reported | Calibration | Accuracy |
| 140 | Requirements for independent calibration verification were not met | Calibration | Accuracy |
| 129 | Frequency or sequencing verification criteria not met | Calibration | Accuracy |
| 131 | Confirmation percent difference criteria not met | Confirmation | Precision |
| 145, 45 | Results were not confirmed | Confirmation | Precision |
| 18 | Sufficient documentation not provided by the laboratory | Documentation issues | Representativeness |
| 705 | Electronic qualifiers were applied from validation report by hand | Documentation issues | Other |
| 805 | Information missing from case narrative | Documentation issues | Other |
| 84 | Key data field incorrect | Documentation issues | Other |
| 802 | Missing deliverables (not required for validation) | Documentation issues | Other |
| 801 | Missing deliverables (required for validation) | Documentation issues | Representativeness |
| 227 | No documentation regarding deviations from methods or SOW | Documentation issues | Other |
| 44 | No mass spectra were provided | Documentation issues | Representativeness |
| 241 | No micro pipette or electroplating data available | Documentation issues | Other |
| 26 | No raw data submitted by the laboratory | Documentation issues | Representativeness |
| 804 | Omissions or errors in SDP (not required for validation) | Documentation issues | Other |
| 803 | Omissions or errors in SDP (required for validation) | Documentation issues | Representativeness |
| 807 | Original documentation not provided | Documentation issues | Other |
| 85 | Record added by the validator | Documentation issues | Other |

Table A2.4
Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

| Validation Reason Codes | Standardized Description | QC Category | Affected PARCC Parameter |
|-------------------------|--|-----------------------|--------------------------|
| 152 | Reported data do not agree with raw data | Documentation issues | Other |
| 89 | Sample analysis was not requested | Documentation issues | Other |
| 218 | Sample COC was not verifiable (attributed to laboratory) | Documentation issues | Representativeness |
| 704 | Sample COC was not verifiable (not attributed to laboratory) | Documentation issues | Representativeness |
| 83 | Sample results were not included on Data Summary Table | Documentation issues | Other |
| 52 | Transcription error | Documentation issues | Other |
| 205 | Unobtainable omissions or errors on SDP (required for data assessment) | Documentation issues | Representativeness |
| 1, 101, 701 | Holding times were exceeded | Holding times | Representativeness |
| 2, 102, 702 | Holding times were grossly exceeded | Holding times | Representativeness |
| 251 | Misidentified target compounds | Identification errors | Representativeness |
| 70 | Resolution criteria not met | Identification errors | Representativeness |
| 226 | TIC misidentification | Identification errors | Representativeness |
| 143, 43 | Internal standards did not meet criteria | Internal standards | Accuracy |
| 5 | CRDL check sample recovery criteria were not met | LCS | Accuracy |
| 33 | LCS > ± 2 sigma and < ± 3 sigma | LCS | Accuracy |
| 10, 110, 236 | LCS recovery criteria were not met | LCS | Accuracy |
| 132, 32 | Laboratory control samples > ± 3 sigma | LCS | Accuracy |
| 174, 74 | LCS data not submitted | LCS | Representativeness |
| 63 | Expected LCS value not submitted/verifiable | LCS | Representativeness |
| 62 | LCS relative percent error criteria not met | LCS | Accuracy |
| 105 | Low-level check sample recovery criteria were not met | LCS | Accuracy |
| 230 | QC sample/analyte (e.g., spike, duplicate, LCS) not analyzed | LCS | Representativeness |
| 28 | Duplicate analysis was not performed | Matrices | Precision |
| 11, 235 | Duplicate sample precision criteria were not met | Matrices | Precision |
| 111 | LCS/LCSD precision criteria were not met | Matrices | Precision |
| 128 | Laboratory duplicate was not analyzed | Matrices | Precision |
| 231 | MS/MSD criteria not met | Matrices | Precision |
| 116, 16 | MSA calibration correlation coefficient < 0.995 | Matrices | Accuracy |
| 115, 15 | MSA was required but not performed | Matrices | Representativeness |
| 58 | Sample contained < 10 percent solid material | Matrices | Representativeness |
| 57 | Sample contained < 30 percent solid material | Matrices | Representativeness |
| 217 | Post-digestion spike recoveries were < 10% | Matrices | Accuracy |
| 14, 114, 216 | Post-digestion matrix spike criteria were not met | Matrices | Accuracy |
| 113, 13 | Predigestion matrix spike recovery is < 30% | Matrices | Accuracy |
| 112, 12 | Predigestion matrix spike recovery criteria were not met | Matrices | Accuracy |
| 27 | Recovery criteria were not met | Matrices | Accuracy |
| 31 | Replicate analysis was not performed | Matrices | Precision |
| 130, 30 | Replicate precision criteria were not met | Matrices | Precision |
| 61 | Replicate recovery criteria were not met | Matrices | Accuracy |
| 233 | Sample matrix QC does not represent samples analyzed | Matrices | Representativeness |
| 117, 17 | Serial dilution criteria not met | Matrices | Accuracy |
| 806 | Site samples not used for sample matrix QC | Matrices | Representativeness |
| 810 | EDD does not match hard copy; EDD may be resubmitted | Other | Other |

Table A2.4
Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

| Validation Reason Codes | Standardized Description | QC Category | Affected PARCC Parameter |
|-------------------------|---|--------------------|--------------------------|
| 214 | IDL is older than 3 months from date of analysis | Other | Accuracy |
| 250 | Incorrect analysis sequence | Other | Representativeness |
| 808 | Incorrect or incomplete DRC | Other | Representativeness |
| 212 | Instrument detection limit was not provided | Other | Other |
| 87 | Laboratory did no analysis for this record | Other | Other |
| 809 | Nonsite samples reported with Site samples | Other | Other |
| 64 | Nontraceable/noncertified standard was used | Other | Accuracy |
| 51 | Nonverifiable laboratory results and/or unsubmitted data | Other | Representativeness |
| 211 | Poor cleanup recovery | Other | Accuracy |
| 25 | Primary standard had exceeded expiration date | Other | Accuracy |
| 234 | QC sample does not meet method requirement | Other | Representativeness |
| 168, 68 | QC sample frequency does not meet requirements | Other | Representativeness |
| 252 | Result is suspect due to dilution | Other | Other |
| 79 | Result obtained through dilution | Other | Other |
| 37 | Sample exceeded efficiency curve weight limit | Other | Accuracy |
| 247 | Sample or control analyses not chemically separated from each other | Other | Representativeness |
| 90 | Sample result was not validated due to re-analysis | Other | Other |
| 67 | Sample results not submitted/verifiable | Other | Representativeness |
| 199, 99 | See hard copy for further explanation | Other | Other |
| 248 | Single combined TCLP results was not reported for sample with both mis+nonm | Other | Accuracy |
| 80 | Spurious counts of unknown origin | Other | Representativeness |
| 244 | Standard or tracer is not NIST traceable | Other | Accuracy |
| 164 | Standard traceability or certification requirements not met | Other | Accuracy |
| 219 | Standards have expired or are not valid | Other | Accuracy |
| 243 | Standard values were not calculated correctly (LCS, tracer, standards) | Other | Other |
| 22 | Tracer contamination | Other | Accuracy |
| 242 | Tracer requirements were not met | Other | Accuracy |
| 71 | Unit conversion of results | Other | Other |
| 239 | Winsorized mean+standard deviation of the same not calculated or calculated wrong | Other | Other |
| 38 | Excessive solids on planchet | Sample preparation | Accuracy |
| 123, 23 | Improper aliquot size | Sample preparation | Accuracy |
| 224 | Incomplete TCLP extraction data | Sample preparation | Representativeness |
| 225 | Insufficient TCLP extraction time | Sample preparation | Representativeness |
| 201 | Preservation requirements not met by the laboratory | Sample preparation | Representativeness |
| 24 | Sample aliquot not taken quantitatively | Sample preparation | Accuracy |
| 240 | Sample preparation for soil/sludge/ sediment were not homog/aliquot properly | Sample preparation | Representativeness |
| 207 | Sample pretreatment or preparation method is incorrect | Sample preparation | Representativeness |
| 69 | Samples not distilled | Sample preparation | Representativeness |
| 703 | Samples were not preserved properly in the field | Sample preparation | Representativeness |
| 222 | TCLP particle size was not performed | Sample preparation | Representativeness |
| 220 | TCLP sample percent solids < 0.5 percent | Sample preparation | Representativeness |

Table A2.4
Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

| Validation Reason Codes | Standardized Description | QC Category | Affected PARCC Parameter |
|-------------------------|--|-------------------|--------------------------|
| 56 | IDL changed due to significant figure discrepancy | Sensitivity | Representativeness |
| 54 | Incorrect reported activity or MDA | Sensitivity | Other |
| 213 | Instrument detection limit > the associated RDL | Sensitivity | Representativeness |
| 136, 36 | MDA exceeded the RDL | Sensitivity | Representativeness |
| 78 | MDA was calculated by reviewer | Sensitivity | Other |
| 81 | Repeat count outside of 3 sigma counting error | Sensitivity | Precision |
| 86 | Results considered qualitative not quantitative | Sensitivity | Accuracy |
| 82 | Sample results were not corrected for decay | Sensitivity | Other |
| 91 | Unit conversion, QC sample activity uncertainty/MDA | Sensitivity | Representativeness |
| 142, 42 | Surrogates were outside criteria | Surrogate | Accuracy |
| 20 | AA duplicate injection precision criteria were not met | Instrument Set-up | Precision |
| 73 | Daily instrument performance assessment not performed | Instrument Set-up | Accuracy |
| 177, 77 | Detector efficiency criteria not met | Instrument Set-up | Accuracy |
| 229 | Element not analyzed in ICP interference check sample | Instrument Set-up | Representativeness |
| 76 | Instrument gain and/or efficiency not submitted | Instrument Set-up | Representativeness |
| 109, 9 | Interference indicated in the ICP interference check sample | Instrument Set-up | Accuracy |
| 147, 47 | Percent breakdown exceeded 20 percent | Instrument Set-up | Representativeness |
| 170 | Resolution criteria not met | Instrument Set-up | Representativeness |
| 35 | Transformed spectral index external site criteria were not met | Instrument Set-up | Representativeness |
| 139, 39 | Tune criteria not met | Instrument Set-up | Accuracy |
| 206 | Analysis was not requested according to SOW | Unknown | Other |
| 166 | Carrier aliquot nonverifiable | Unknown | Representativeness |
| 150 | Unknown carrier volume | Unknown | Representativeness |

Table A2.5
Summary of V&V Observations

| Analyte Group | Matrix | QC Category | V&V Observation | Detect? | No. of Qualified Results | Total No. of V&V Records | Percent Qualified (%) |
|--------------------|--------|----------------------|---|---------|--------------------------|--------------------------|-----------------------|
| Dioxins and Furans | WATER | Documentation Issues | Record added by the validator | No | 1 | 1 | 100.00 |
| Herbicide | WATER | Calibration | Continuing calibration verification criteria were not met | No | 1 | 7 | 14.29 |
| Metal | SOIL | Blanks | Calibration verification blank contamination | No | 48 | 831 | 5.78 |
| Metal | SOIL | Blanks | Calibration verification blank contamination | Yes | 4 | 831 | 0.48 |
| Metal | SOIL | Blanks | Method, preparation, or reagent blank contamination | No | 10 | 831 | 1.20 |
| Metal | SOIL | Blanks | Negative bias indicated in the blanks | No | 1 | 831 | 0.12 |
| Metal | SOIL | Blanks | Negative bias indicated in the blanks | Yes | 4 | 831 | 0.48 |
| Metal | SOIL | Calibration | Calibration correlation coefficient did not meet requirements | No | 2 | 831 | 0.24 |
| Metal | SOIL | Documentation Issues | Transcription error | No | 11 | 831 | 1.32 |
| Metal | SOIL | Documentation Issues | Transcription error | Yes | 46 | 831 | 5.54 |
| Metal | SOIL | Holding Times | Holding times were exceeded | No | 1 | 831 | 0.12 |
| Metal | SOIL | Instrument Set-up | Interference was indicated in the interference check sample | Yes | 5 | 831 | 0.60 |
| Metal | SOIL | LCS | CRDL check sample recovery criteria were not met | No | 4 | 831 | 0.48 |
| Metal | SOIL | LCS | CRDL check sample recovery criteria were not met | Yes | 1 | 831 | 0.12 |
| Metal | SOIL | LCS | LCS recovery criteria were not met | No | 7 | 831 | 0.84 |
| Metal | SOIL | LCS | LCS recovery criteria were not met | Yes | 12 | 831 | 1.44 |
| Metal | SOIL | LCS | Low level check sample recovery criteria were not met | No | 14 | 831 | 1.68 |
| Metal | SOIL | LCS | Low level check sample recovery criteria were not met | Yes | 1 | 831 | 0.12 |
| Metal | SOIL | Matrices | Duplicate sample precision criteria were not met | Yes | 6 | 831 | 0.72 |
| Metal | SOIL | Matrices | LCS/LCSD precision criteria were not met | Yes | 1 | 831 | 0.12 |
| Metal | SOIL | Matrices | Post-digestion MS did not meet control criteria | No | 6 | 831 | 0.72 |
| Metal | SOIL | Matrices | Post-digestion MS did not meet control criteria | Yes | 5 | 831 | 0.60 |
| Metal | SOIL | Matrices | Predigestion MS recovery criteria were not met | No | 18 | 831 | 2.17 |
| Metal | SOIL | Matrices | Predigestion MS recovery criteria were not met | Yes | 58 | 831 | 6.98 |
| Metal | SOIL | Matrices | Serial dilution criteria were not met | Yes | 52 | 831 | 6.26 |
| Metal | SOIL | Other | IDL is older than 3 months from date of analysis | No | 90 | 831 | 10.83 |
| Metal | SOIL | Other | IDL is older than 3 months from date of analysis | Yes | 298 | 831 | 35.86 |
| Metal | SOIL | Other | Result obtained through dilution | Yes | 1 | 831 | 0.12 |
| Metal | WATER | Blanks | Calibration verification blank contamination | No | 57 | 1,647 | 3.46 |
| Metal | WATER | Blanks | Calibration verification blank contamination | Yes | 12 | 1,647 | 0.73 |
| Metal | WATER | Blanks | Method, preparation, or reagent blank contamination | No | 148 | 1,647 | 8.99 |
| Metal | WATER | Blanks | Method, preparation, or reagent blank contamination | Yes | 11 | 1,647 | 0.67 |
| Metal | WATER | Blanks | Negative bias indicated in the blanks | No | 16 | 1,647 | 0.97 |
| Metal | WATER | Blanks | Negative bias indicated in the blanks | Yes | 7 | 1,647 | 0.43 |
| Metal | WATER | Calibration | Calibration correlation coefficient did not meet requirements | No | 4 | 1,647 | 0.24 |
| Metal | WATER | Calibration | Calibration correlation coefficient did not meet requirements | Yes | 5 | 1,647 | 0.30 |
| Metal | WATER | Calibration | Continuing calibration verification criteria were not met | Yes | 1 | 1,647 | 0.06 |
| Metal | WATER | Documentation Issues | Key data fields incorrect | No | 5 | 1,647 | 0.30 |
| Metal | WATER | Documentation Issues | Missing deliverables (not required for validation) | No | 1 | 1,647 | 0.06 |
| Metal | WATER | Documentation Issues | Missing deliverables (not required for validation) | Yes | 1 | 1,647 | 0.06 |
| Metal | WATER | Documentation Issues | Missing deliverables (required for validation) | No | 10 | 1,647 | 0.61 |
| Metal | WATER | Documentation Issues | Missing deliverables (required for validation) | Yes | 18 | 1,647 | 1.09 |
| Metal | WATER | Documentation Issues | Omissions or errors in data package (not required for validation) | No | 22 | 1,647 | 1.34 |
| Metal | WATER | Documentation Issues | Omissions or errors in data package (not required for validation) | Yes | 31 | 1,647 | 1.88 |
| Metal | WATER | Documentation Issues | Transcription error | No | 68 | 1,647 | 4.13 |
| Metal | WATER | Holding Times | Holding times were exceeded | No | 2 | 1,647 | 0.12 |
| Metal | WATER | Instrument Set-up | Interference was indicated in the interference check sample | No | 1 | 1,647 | 0.06 |
| Metal | WATER | Instrument Set-up | Interference was indicated in the interference check sample | Yes | 3 | 1,647 | 0.18 |
| Metal | WATER | LCS | CRDL check sample recovery criteria were not met | No | 4 | 1,647 | 0.24 |
| Metal | WATER | LCS | CRDL check sample recovery criteria were not met | Yes | 6 | 1,647 | 0.36 |
| Metal | WATER | LCS | LCS recovery criteria were not met | No | 2 | 1,647 | 0.12 |
| Metal | WATER | LCS | LCS recovery criteria were not met | Yes | 8 | 1,647 | 0.49 |
| Metal | WATER | LCS | Low level check sample recovery criteria were not met | No | 23 | 1,647 | 1.40 |

Table A2.5
Summary of V&V Observations

| Analyte Group | Matrix | QC Category | V&V Observation | Detected | No. of Qualified Results | Total No. of V&V Records | Percent Qualified (%) |
|---------------|--------|----------------------|---|----------|--------------------------|--------------------------|-----------------------|
| Metal | WATER | LCS | Low level check sample recovery criteria were not met | Yes | 22 | 1,647 | 1.34 |
| Metal | WATER | Matrices | Duplicate sample precision criteria were not met | No | 2 | 1,647 | 0.12 |
| Metal | WATER | Matrices | Duplicate sample precision criteria were not met | Yes | 3 | 1,647 | 0.18 |
| Metal | WATER | Matrices | LCS/LCSD precision criteria were not met | No | 2 | 1,647 | 0.12 |
| Metal | WATER | Matrices | LCS/LCSD precision criteria were not met | Yes | 2 | 1,647 | 0.12 |
| Metal | WATER | Matrices | MSA calibration correlation coefficient < 0.995 | Yes | 1 | 1,647 | 0.06 |
| Metal | WATER | Matrices | Post-digestion MS did not meet control criteria | No | 14 | 1,647 | 0.85 |
| Metal | WATER | Matrices | Post-digestion MS did not meet control criteria | Yes | 7 | 1,647 | 0.43 |
| Metal | WATER | Matrices | Predigestion MS recovery criteria were not met | No | 23 | 1,647 | 1.40 |
| Metal | WATER | Matrices | Predigestion MS recovery criteria were not met | Yes | 22 | 1,647 | 1.34 |
| Metal | WATER | Matrices | Predigestion MS recovery was < 30 percent | Yes | 2 | 1,647 | 0.12 |
| Metal | WATER | Matrices | Serial dilution criteria were not met | No | 1 | 1,647 | 0.06 |
| Metal | WATER | Matrices | Serial dilution criteria were not met | Yes | 41 | 1,647 | 2.49 |
| Metal | WATER | Other | IDL is older than 3 months from date of analysis | No | 61 | 1,647 | 3.70 |
| Metal | WATER | Other | IDL is older than 3 months from date of analysis | Yes | 55 | 1,647 | 3.34 |
| Metal | WATER | Other | See hard copy for further explanation | No | 2 | 1,647 | 0.12 |
| Metal | WATER | Other | See hard copy for further explanation | Yes | 7 | 1,647 | 0.43 |
| Metal | WATER | Sample Preparation | Samples were not properly preserved in the field | No | 12 | 1,647 | 0.73 |
| Metal | WATER | Sample Preparation | Samples were not properly preserved in the field | Yes | 15 | 1,647 | 0.91 |
| Metal | WATER | Sensitivity | IDL changed due to a significant figure discrepancy | No | 7 | 1,647 | 0.43 |
| PCB | WATER | Documentation Issues | Transcription error | No | 8 | 35 | 22.86 |
| PCB | WATER | Surrogates | Surrogate recovery criteria were not met | No | 7 | 35 | 20.00 |
| Pesticide | WATER | Calibration | Continuing calibration verification criteria were not met | No | 8 | 115 | 6.96 |
| Pesticide | WATER | Documentation Issues | Transcription error | No | 2 | 115 | 1.74 |
| Pesticide | WATER | Surrogates | Surrogate recovery criteria were not met | No | 21 | 115 | 18.26 |
| Radionuclide | SOIL | Blanks | Method, preparation, or reagent blank contamination | Yes | 18 | 291 | 6.19 |
| Radionuclide | SOIL | Calibration | Continuing calibration verification criteria were not met | Yes | 2 | 291 | 0.69 |
| Radionuclide | SOIL | Documentation Issues | Record added by the validator | Yes | 32 | 291 | 11.00 |
| Radionuclide | SOIL | Documentation Issues | Sufficient documentation not provided by the laboratory | Yes | 32 | 291 | 11.00 |
| Radionuclide | SOIL | Documentation Issues | Transcription error | Yes | 19 | 291 | 6.53 |
| Radionuclide | SOIL | Instrument Set-up | Resolution criteria were not met | Yes | 1 | 291 | 0.34 |
| Radionuclide | SOIL | LCS | LCS recovery > +/- 3 sigma | Yes | 7 | 291 | 2.41 |
| Radionuclide | SOIL | LCS | LCS recovery criteria were not met | Yes | 4 | 291 | 1.37 |
| Radionuclide | SOIL | LCS | LCS relative percent error criteria not met | No | 1 | 291 | 0.34 |
| Radionuclide | SOIL | LCS | LCS relative percent error criteria not met | Yes | 39 | 291 | 13.40 |
| Radionuclide | SOIL | Matrices | Recovery criteria were not met | Yes | 3 | 291 | 1.03 |
| Radionuclide | SOIL | Matrices | Replicate precision criteria were not met | Yes | 9 | 291 | 3.09 |
| Radionuclide | SOIL | Matrices | Replicate recovery criteria were not met | Yes | 2 | 291 | 0.69 |
| Radionuclide | SOIL | Other | Lab results not verified due to unsubmitted data | Yes | 1 | 291 | 0.34 |
| Radionuclide | SOIL | Other | QC sample does not meet method requirements | No | 27 | 291 | 9.28 |
| Radionuclide | SOIL | Other | QC sample does not meet method requirements | Yes | 23 | 291 | 7.90 |
| Radionuclide | SOIL | Sensitivity | MDA exceeded the RDL | Yes | 1 | 291 | 0.34 |
| Radionuclide | SOIL | Sensitivity | MDA was calculated by reviewer | Yes | 50 | 291 | 17.18 |
| Radionuclide | WATER | Blanks | Method, preparation, or reagent blank contamination | No | 3 | 395 | 0.76 |
| Radionuclide | WATER | Blanks | Method, preparation, or reagent blank contamination | Yes | 16 | 395 | 4.05 |
| Radionuclide | WATER | Calculation Errors | Calculation error | Yes | 2 | 395 | 0.51 |
| Radionuclide | WATER | Calibration | Calibration counting statistics did not meet criteria | No | 3 | 395 | 0.76 |
| Radionuclide | WATER | Calibration | Continuing calibration verification criteria were not met | No | 6 | 395 | 1.52 |
| Radionuclide | WATER | Calibration | Continuing calibration verification criteria were not met | Yes | 63 | 395 | 15.95 |
| Radionuclide | WATER | Documentation Issues | Omissions or errors in data package (not required for validation) | No | 3 | 395 | 0.76 |
| Radionuclide | WATER | Documentation Issues | Omissions or errors in data package (not required for validation) | Yes | 3 | 395 | 0.76 |
| Radionuclide | WATER | Documentation Issues | Record added by the validator | Yes | 8 | 395 | 2.03 |
| Radionuclide | WATER | Documentation Issues | Sufficient documentation not provided by the laboratory | Yes | 34 | 395 | 8.61 |
| Radionuclide | WATER | Documentation Issues | Transcription error | No | 24 | 395 | 6.08 |
| Radionuclide | WATER | Documentation Issues | Transcription error | Yes | 16 | 395 | 4.05 |
| Radionuclide | WATER | Holding Times | Holding times were exceeded | No | 1 | 395 | 0.25 |
| Radionuclide | WATER | Holding Times | Holding times were exceeded | Yes | 1 | 395 | 0.25 |

Table A2.5
Summary of V&V Observations

| Analyte Group | Matrix | QC Category | V&V Observation | Defect? | No. of Qualified Results | Total No. of V&V Records | Percent Qualified (%) |
|---------------|--------|----------------------|---|---------|--------------------------|--------------------------|-----------------------|
| Radionuclide | WATER | Instrument Set-up | Transformed spectral index external site criteria were not met | No | 3 | 395 | 0.76 |
| Radionuclide | WATER | LCS | Expected LCS value not submitted/verifiable | No | 1 | 395 | 0.25 |
| Radionuclide | WATER | LCS | Expected LCS value not submitted/verifiable | Yes | 5 | 395 | 1.27 |
| Radionuclide | WATER | LCS | LCS data not submitted by the laboratory | Yes | 3 | 395 | 0.76 |
| Radionuclide | WATER | LCS | LCS recovery > +/- 3 sigma | No | 9 | 395 | 2.28 |
| Radionuclide | WATER | LCS | LCS recovery > +/- 3 sigma | Yes | 11 | 395 | 2.78 |
| Radionuclide | WATER | LCS | LCS recovery criteria were not met | No | 1 | 395 | 0.25 |
| Radionuclide | WATER | LCS | LCS recovery criteria were not met | Yes | 2 | 395 | 0.51 |
| Radionuclide | WATER | LCS | LCS relative percent error criteria not met | No | 4 | 395 | 1.01 |
| Radionuclide | WATER | LCS | LCS relative percent error criteria not met | Yes | 18 | 395 | 4.56 |
| Radionuclide | WATER | Matrices | Recovery criteria were not met | No | 1 | 395 | 0.25 |
| Radionuclide | WATER | Matrices | Recovery criteria were not met | Yes | 6 | 395 | 1.52 |
| Radionuclide | WATER | Matrices | Replicate analysis was not performed | No | 7 | 395 | 1.77 |
| Radionuclide | WATER | Matrices | Replicate analysis was not performed | Yes | 6 | 395 | 1.52 |
| Radionuclide | WATER | Matrices | Replicate precision criteria were not met | No | 1 | 395 | 0.25 |
| Radionuclide | WATER | Matrices | Replicate precision criteria were not met | Yes | 26 | 395 | 6.58 |
| Radionuclide | WATER | Matrices | Replicate recovery criteria were not met | No | 1 | 395 | 0.25 |
| Radionuclide | WATER | Matrices | Replicate recovery criteria were not met | Yes | 2 | 395 | 0.51 |
| Radionuclide | WATER | Other | QC sample does not meet method requirements | No | 3 | 395 | 0.76 |
| Radionuclide | WATER | Other | See hard copy for further explanation | Yes | 21 | 395 | 5.32 |
| Radionuclide | WATER | Other | Tracer requirements were not met | No | 1 | 395 | 0.25 |
| Radionuclide | WATER | Other | Tracer requirements were not met | Yes | 9 | 395 | 2.28 |
| Radionuclide | WATER | Sensitivity | MDA exceeded the RDL | No | 7 | 395 | 1.77 |
| Radionuclide | WATER | Sensitivity | MDA exceeded the RDL | Yes | 16 | 395 | 4.05 |
| Radionuclide | WATER | Sensitivity | MDA was calculated by reviewer | Yes | 111 | 395 | 28.10 |
| SVOC | WATER | Blanks | Method, preparation, or reagent blank contamination | No | 3 | 308 | 0.97 |
| SVOC | WATER | Calibration | Continuing calibration verification criteria were not met | No | 9 | 308 | 2.92 |
| SVOC | WATER | Calibration | Independent calibration verification criteria not met | No | 1 | 308 | 0.32 |
| SVOC | WATER | Documentation Issues | Omissions or errors in data package (not required for validation) | No | 6 | 308 | 1.95 |
| SVOC | WATER | Documentation Issues | Transcription error | No | 11 | 308 | 3.57 |
| SVOC | WATER | Documentation Issues | Transcription error | Yes | 1 | 308 | 0.32 |
| SVOC | WATER | Holding Times | Holding times were exceeded | No | 13 | 308 | 4.22 |
| SVOC | WATER | Instrument Set-up | Instrument tune criteria were not met | No | 9 | 308 | 2.92 |
| SVOC | WATER | LCS | LCS recovery criteria were not met | No | 3 | 308 | 0.97 |
| SVOC | WATER | Other | Sample results were not validated due to re-analysis | No | 9 | 308 | 2.92 |
| SVOC | WATER | Other | Sample results were not validated due to re-analysis | Yes | 1 | 308 | 0.32 |
| SVOC | WATER | Other | See hard copy for further explanation | No | 8 | 308 | 2.60 |
| VOC | SOIL | Blanks | Method, preparation, or reagent blank contamination | No | 3 | 186 | 1.61 |
| VOC | SOIL | Documentation Issues | Transcription error | No | 1 | 186 | 0.54 |
| VOC | SOIL | Holding Times | Holding times were exceeded | No | 34 | 186 | 18.28 |
| VOC | WATER | Blanks | Method, preparation, or reagent blank contamination | No | 17 | 2,629 | 0.65 |
| VOC | WATER | Blanks | Method, preparation, or reagent blank contamination | Yes | 2 | 2,629 | 0.08 |
| VOC | WATER | Calibration | Continuing calibration verification criteria were not met | No | 29 | 2,629 | 1.10 |
| VOC | WATER | Calibration | Independent calibration verification criteria not met | No | 2 | 2,629 | 0.08 |
| VOC | WATER | Confirmation | Results were not confirmed | No | 2 | 2,629 | 0.08 |
| VOC | WATER | Confirmation | Results were not confirmed | Yes | 1 | 2,629 | 0.04 |
| VOC | WATER | Documentation Issues | Omissions or errors in data package (not required for validation) | No | 109 | 2,629 | 4.15 |
| VOC | WATER | Documentation Issues | Record added by the validator | No | 2 | 2,629 | 0.08 |
| VOC | WATER | Documentation Issues | Transcription error | No | 87 | 2,629 | 3.31 |
| VOC | WATER | Holding Times | Holding times were exceeded | No | 155 | 2,629 | 5.90 |
| VOC | WATER | Instrument Set-up | Instrument tune criteria were not met | No | 162 | 2,629 | 6.16 |
| VOC | WATER | Instrument Set-up | Instrument tune criteria were not met | Yes | 2 | 2,629 | 0.08 |
| VOC | WATER | LCS | LCS recovery criteria were not met | No | 74 | 2,629 | 2.81 |
| VOC | WATER | LCS | LCS recovery criteria were not met | Yes | 1 | 2,629 | 0.04 |
| VOC | WATER | Other | Sample results were not validated due to re-analysis | No | 34 | 2,629 | 1.29 |
| VOC | WATER | Other | See hard copy for further explanation | No | 1 | 2,629 | 0.04 |
| Wet Chemistry | SOIL | Matrices | Predigestion MS recovery was < 30 percent | Yes | 15 | 18 | 83.33 |
| Wet Chemistry | SOIL | Other | IDL is older than 3 months from date of analysis | Yes | 17 | 18 | 94.44 |

Table A2.5
Summary of V&V Observations

| Analyte Group | Matrix | QC Category | V&V Observation | Defect? | No. of Qualified Results | Total No. of V&V Records | Percent Qualified % |
|---------------|--------|----------------------|---|---------|--------------------------|--------------------------|---------------------|
| Wet Chemistry | WATER | Calibration | Calibration correlation coefficient did not meet requirements | Yes | 1 | 257 | 0.39 |
| Wet Chemistry | WATER | Calibration | Continuing calibration verification criteria were not met | Yes | 1 | 257 | 0.39 |
| Wet Chemistry | WATER | Documentation Issues | Missing deliverables (not required for validation) | No | 1 | 257 | 0.39 |
| Wet Chemistry | WATER | Documentation Issues | Missing deliverables (not required for validation) | Yes | 2 | 257 | 0.78 |
| Wet Chemistry | WATER | Documentation Issues | Omissions or errors in data package (not required for validation) | No | 3 | 257 | 1.17 |
| Wet Chemistry | WATER | Documentation Issues | Omissions or errors in data package (not required for validation) | Yes | 6 | 257 | 2.33 |
| Wet Chemistry | WATER | Documentation Issues | Transcription error | No | 4 | 257 | 1.56 |
| Wet Chemistry | WATER | Documentation Issues | Transcription error | Yes | 9 | 257 | 3.50 |
| Wet Chemistry | WATER | Holding Times | Holding times were exceeded | No | 2 | 257 | 0.78 |
| Wet Chemistry | WATER | Holding Times | Holding times were exceeded | Yes | 5 | 257 | 1.95 |
| Wet Chemistry | WATER | Holding Times | Holding times were grossly exceeded | No | 1 | 257 | 0.39 |
| Wet Chemistry | WATER | Matrices | Predigestion MS recovery criteria were not met | Yes | 2 | 257 | 0.78 |
| Wet Chemistry | WATER | Matrices | Site samples were not used for sample matrix QC | No | 1 | 257 | 0.39 |
| Wet Chemistry | WATER | Matrices | Site samples were not used for sample matrix QC | Yes | 2 | 257 | 0.78 |
| Wet Chemistry | WATER | Other | IDL is older than 3 months from date of analysis | Yes | 3 | 257 | 1.17 |
| Wet Chemistry | WATER | Other | Lab results not verified due to unsubmitted data | Yes | 2 | 257 | 0.78 |
| Wet Chemistry | WATER | Other | See hard copy for further explanation | No | 1 | 257 | 0.39 |
| Wet Chemistry | WATER | Other | See hard copy for further explanation | Yes | 2 | 257 | 0.78 |

Table A2.6
Summary of Data Rejected During V&V

| Analyte Group | Matrix | Total No. of Rejected Records | Total No. of Records | Percent Rejected (%) |
|--------------------|--------------|-------------------------------|----------------------|----------------------|
| Dioxins and Furans | WATER | 0 | 1 | 0.00 |
| Herbicide | SOIL | 0 | 5 | 0.00 |
| Herbicide | WATER | 0 | 7 | 0.00 |
| Metal | SOIL | 15 | 988 | 1.52 |
| Metal | WATER | 46 | 2,233 | 2.06 |
| PCB | SOIL | 0 | 7 | 0.00 |
| PCB | WATER | 0 | 35 | 0.00 |
| Pesticide | SOIL | 0 | 25 | 0.00 |
| Pesticide | WATER | 0 | 115 | 0.00 |
| Radionuclide | SOIL | 81 | 408 | 19.85 |
| Radionuclide | WATER | 57 | 591 | 9.64 |
| SVOC | SOIL | 0 | 295 | 0.00 |
| SVOC | WATER | 9 | 349 | 2.58 |
| VOC | SOIL | 11 | 496 | 2.22 |
| VOC | WATER | 62 | 3,280 | 1.89 |
| Wet Chemistry | SOIL | 0 | 18 | 0.00 |
| Wet Chemistry | WATER | 7 | 397 | 1.76 |
| | Total | 288 | 9,250 | 3.11% |

Table A2.7
Summary of RPDs/DERs of Field Duplicate Analyte Pairs

| Analyte Group | Matrix | No. of Duplicates Failing RPD/DER Criteria | Total No. of Duplicate Pairs | Percent Failure (%) | Field Duplicate Frequency (%) |
|---------------|--------|--|------------------------------|---------------------|-------------------------------|
| Metal | SOIL | 12 | 60 | 20.00 | 7.22 |
| Metal | WATER | 18 | 221 | 8.14 | 11.90 |
| Radionuclide | SOIL | 2 | 23 | 8.70 | 7.59 |
| Radionuclide | WATER | 0 | 52 | 0.00 | 10.90 |
| SVOC | WATER | 0 | 21 | 0.00 | 6.36 |
| VOC | WATER | 0 | 395 | 0.00 | 13.72 |
| Wet Chemistry | SOIL | 0 | 2 | 0.00 | 11.11 |
| Wet Chemistry | WATER | 0 | 24 | 0.00 | 8.36 |

Table A2.8
Summary of Data Estimated or Undetected Due to V&V Determinations

| Analyte Group | Matrix | No. of CRA Data Records Qualified | Total No. of V&V CRA Records | Detect? | Percent Qualified (%) |
|---------------|--------------|---|---------------------------------|---------|-----------------------------|
| Herbicide | WATER | 1 | 7 | No | 14.29 |
| Metal | SOIL | 101 | 831 | No | 12.15 |
| Metal | SOIL | 130 | 831 | Yes | 15.64 |
| Metal | WATER | 273 | 1,647 | No | 16.58 |
| Metal | WATER | 138 | 1,647 | Yes | 8.38 |
| PCB | WATER | 7 | 35 | No | 20.00 |
| Pesticide | WATER | 28 | 115 | No | 24.35 |
| Radionuclide | SOIL | 1 | 291 | Yes | 0.34 |
| Radionuclide | WATER | 6 | 395 | No | 1.52 |
| Radionuclide | WATER | 15 | 395 | Yes | 3.80 |
| SVOC | WATER | 33 | 308 | No | 10.71 |
| VOC | SOIL | 37 | 186 | No | 19.89 |
| VOC | WATER | 264 | 2,629 | No | 10.04 |
| VOC | WATER | 2 | 2,629 | Yes | 0.08 |
| Wet Chemistry | SOIL | 15 | 18 | Yes | 83.33 |
| Wet Chemistry | WATER | 3 | 257 | No | 1.17 |
| Wet Chemistry | WATER | 11 | 257 | Yes | 4.28 |
| | Total | 1,065 | 6,991 | | 15.23% |

Table A2.9
Summary of Data Qualified as Undetected Due to Blank Contamination

| Analyte Group | Matrix | No. of CRA Records Qualified as Undetected | Total No. of CRA Records with Detected Results ^a | Percent Qualified as Undetected |
|---------------|--------------|--|---|---------------------------------|
| Metal | SOIL | 34 | 633 | 5.37 |
| Metal | WATER | 29 | 735 | 3.95 |
| VOC | WATER | 1 | 15 | 6.67 |
| | Total | 64 | 1383 | 4.63% |

^a As determined by the laboratory prior to V&V.

COMPREHENSIVE RISK ASSESSMENT

SOUTHEAST BUFFER ZONE AREA EXPOSURE UNIT

VOLUME 13: ATTACHMENT 3

Statistical Analyses and Professional Judgment

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ACRONYMS AND ABBREVIATIONS

| | |
|--------|---|
| BZ | Buffer Zone |
| COC | contaminant of concern |
| CRA | Comprehensive Risk Assessment |
| DOE | U.S. Department of Energy |
| ECOI | ecological contaminant of interest |
| EcoSSL | Ecological Soil Screening Level |
| ECOPC | ecological contaminant of potential concern |
| EPA | U.S. Environmental Protection Agency |
| EPC | exposure point concentration |
| ERA | Ecological Risk Assessment |
| ESL | ecological screening level |
| EU | Exposure Unit |
| HHRA | Human Health Risk Assessment |
| IHSS | Individual Hazardous Substance Site |
| MDC | maximum detected concentration |
| mg/kg | milligrams per kilogram |
| NCP | National Contingency Plan |
| NOAEL | no observed adverse effect level |
| PCOC | potential contaminant of concern |
| PMJM | Preble's meadow jumping mouse |
| PRG | preliminary remediation goal |
| RFETS | Rocky Flats Environmental Technology Site |
| RI/FS | Remedial Investigation/Feasibility Study |

| | |
|------|--|
| SEEU | Southeast Buffer Zone Area Exposure Unit |
| tESL | threshold ESL |
| UCL | upper confidence limit |
| UTL | upper tolerance limit |
| WRW | wildlife refuge worker |

1.0 INTRODUCTION

This attachment presents the results for the statistical analyses and professional judgment evaluation used to select human health contaminants of concern (COCs) as part of the Human Health Risk Assessment (HHRA) and ecological contaminants of potential concern (ECOPCs) as part of the Ecological Risk Assessment (ERA) for the Southeast Buffer Zone (BZ) Area Exposure Unit (EU) (SEEU) at the Rocky Flats Environmental Technology Site (RFETS). The methods used to perform the statistical analysis and to develop the professional judgment sections are described in Appendix A, Volume 2, Section 2.0 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation/Corrective Measures Study (CMS)-Feasibility Study (RI/FS) Report (hereafter referred to as the RI/FS Report) and follow the Final Comprehensive Risk Assessment (CRA) Work Plan and Methodology (DOE 2005).

2.0 RESULTS OF STATISTICAL COMPARISONS TO BACKGROUND FOR THE SOUTHEAST BUFFER ZONE AREA EXPOSURE UNIT

The results of the statistical background comparisons for inorganic and radionuclide potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) in surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil samples collected from the SEEU are presented in this section. Box plots are provided for analytes that were carried forward into the statistical comparison step and are presented in Figures A3.2.1 to A3.2.17.¹ The box plots display several reference points: 1) the line inside the box is the median; 2) the lower edge of the box is the 25th percentile; 3) the upper edge of the box is the 75th percentile; 4) the upper lines (called whiskers) are drawn to the greatest value that is less than or equal to 1.5 times the inter-quartile range (the inter-quartile range is between the 75th and 25th percentiles); 5) the lower whiskers are drawn to the lowest value that is greater than or equal to 1.5 times the inter-quartile range; and 6) solid circles are data points greater or less than the whiskers.

ECOIs for surface soil (Preble's meadow jumping mouse [PMJM] receptor) and PCOCs with concentrations in the SEEU that are statistically greater than background (or those where background comparisons were not performed) are carried through to the professional judgment step of the COC/ECOPC selection processes. ECOIs (for non-PMJM receptors) with concentrations in the SEEU that are statistically greater than

¹ Statistical background comparisons are not performed for analytes if: (1) the background concentrations are nondetections; (2) background data are unavailable; (3) the analyte has low detection frequency in the SEEU or background data set (< 20 percent); or (4) the analyte is an organic compound. Box plots are not provided for these analytes. However, these analytes are carried forward into the professional judgment evaluation.

background (or those where background comparisons were not performed) are carried through to the exposure point concentration (EPC) – threshold Ecological Screening Level (tESL) comparison step of the ECOPC selection processes.

PCOCs and ECOIs with concentrations that are not statistically greater than background are not identified as COCs/ECOPCs and are not evaluated further.

2.1 Surface Soil/Surface Sediment Data Used in the HHRA

For the SEEU surface soil/surface sediment data set, the maximum detected concentrations (MDCs) and upper confidence limits on the mean (UCLs) for arsenic, manganese, cesium-137, and radium-228 exceed the wildlife refuge worker (WRW) preliminary remediation goals (PRGs) for the SEEU data set, and these PCOCs were carried forward into the statistical background comparison step. The results of the statistical comparison of the SEEU surface soil/surface sediment data to background data for these PCOCs are presented in Table A3.2.1 and the summary statistics for background and SEEU surface soil/surface sediment data are shown in Table A3.2.2. The SEEU data set shows that the background analysis for cesium-137 and radium-228 could not be conducted because only one sample was collected for these analytes at the SEEU.

The MDCs for aluminum, iron and vanadium exceeded their respective PRGs, but the UCLs for the SEEU data set for these analytes did not exceed the PRG. Consequently, these analytes were not evaluated further. The SEEU MDCs for all other PCOCs do not exceed the PRGs and were not evaluated further.

The results of the statistical comparisons of the SEEU surface soil/surface sediment data to background data indicate the following:

Analytes Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Manganese

Analytes Not Statistically Greater than Background at the 0.1 Significance Level

- None

Background Comparison Not Performed'

- Cesium-137
- Radium-228

2.2 Subsurface Soil/Subsurface Sediment Data Used in the HHRA

For the SEEU PCOCs in subsurface soil/subsurface sediment, the MDC and UCL for radium-228 exceeded the PRG; therefore, radium-228 was carried forward into the statistical background comparison step. The results of the statistical comparison of the

SEEU subsurface soil/subsurface sediment data to background data for radium-228 are presented in Table A3.2.3 and the summary statistics for background and SEEU subsurface soil/subsurface sediment radium-228 data are shown in Table A3.2.4.

The results of the statistical comparison of the SEEU subsurface soil/subsurface sediment data to background data indicate the following:

Analytes Statistically Greater than Background at the 0.1 Significance Level

- None

Analytes Not Statistically Greater than Background at the 0.1 Significance Level

- Radium-228

Background Comparison Not Performed¹

- None

2.3 Surface Soil Data Used in the ERA (Non-PMJM Receptors)

For the ECOIs in surface soil at SEEU, the MDCs for aluminum, arsenic, barium, boron, cadmium, chromium, copper, lead, lithium, manganese, mercury, molybdenum, nickel, vanadium, and zinc exceed a non-PMJM ESL, and these ECOIs were carried forward into the statistical background comparison step. The results of the statistical comparison of the SEEU surface soil data to background data are presented in Table A3.2.5 and the summary statistics for background and SEEU surface soil data are shown in Table A3.2.6.

The results of the statistical comparisons of the SEEU surface soil to background data indicate the following:

Analytes Statistically Greater than Background at the 0.1 Significance Level

- Aluminum
- Barium
- Chromium
- Copper
- Lithium
- Manganese
- Nickel
- Vanadium
- Zinc

Analytes Not Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Cadmium
- Lead
- Mercury

Background Comparison not Performed'

- Boron
- Molybdenum

2.4 Surface Soil Data used in the ERA (PMJM Receptors)

Because viable habitat for PMJM within the SEEU is a small subset of two larger PMJM habitat patches in adjacent EUs, the assessment of risk to the PMJM receptors is addressed in the Lower Woman Drainage EU (LWOEU) and the Southwest Buffer Zone Area EU (SWEU). Therefore, any discussions of risks to PMJM receptors that are associated with the small PMJM habitat within the SEEU are presented in Volume 11 (LWOEU) and Volume 12 (SWEU) of Appendix A of the RI/FS Report.

2.5 Subsurface Soil Data used in the ERA

For the ECOIs in subsurface soil, the MDC for arsenic exceeds the prairie dog ESL, thus arsenic was carried forward into the statistical background comparison step. The MDCs for all other ECOIs did not exceed the prairie dog ESL. The results of the statistical comparison of the SEEU subsurface soil data to background data are presented in Table A3.2.7 and the summary statistics for background and SEEU subsurface soil data are shown in Table A3.2.8.

The results of the statistical comparisons of the surface soil data to background data indicate the following:

Analyte Statistically Greater than Background at the 0.1 Significance Level

- Arsenic

Analyte Not Statistically Greater than Background at the 0.1 Significance Level

- None

Background Comparison not Performed'

- None

3.0 UPPER-BOUND EXPOSURE POINT CONCENTRATION COMPARISON TO LIMITING ECOLOGICAL SCREENING LEVELS

ECOs in surface soil and subsurface soil with concentrations that are statistically greater than background, or background comparisons were not performed, are evaluated further by comparing the SEEU upper-bound exposure point concentrations (EPCs) to the limiting threshold (tESLs). The EPCs are the 95 percent UCLs of the 90th percentile [upper tolerance limit (UTL)] for small home-range receptors, the UCL for large home-range receptors, or the MDC in the event that the UCL or UTL is greater than the MDC.

3.1 ECOs in Surface Soil

Barium in surface soil (non-PMJM receptors) was eliminated from further consideration because its upper-bound EPC was not greater than the tESLs.

Aluminum, boron, chromium, copper, lithium, manganese, molybdenum, nickel, vanadium and zinc for soil surface (non-PMJM receptors) have upper-bound EPCs greater than the tESLs and are evaluated in the professional judgment evaluation screening step (Section 4.0).

3.2 ECOs in Subsurface Soil

Arsenic in subsurface soil was eliminated from further consideration because its upper-bound EPC was not greater than the tESLs.

4.0 PROFESSIONAL JUDGMENT

This section presents the results of the professional judgment step of the COC and ECOPC selection processes for the HHRA and ERA, respectively. Based on the weight of evidence evaluated in the professional judgment step, PCOCs and ECOs are either included for further evaluation as COCs/ECOPCs in the risk characterization step, or excluded from further evaluation.

The professional judgment evaluation takes into account the following lines of evidence: process knowledge, spatial trends, pattern recognition², comparison to RFETS

² The pattern recognition evaluation includes the use of probability plots. If two or more distinct populations are evident in the probability plot, this suggests that one or more local releases may have occurred. Conversely, if only one distinct low-concentration population is defined, likely representing a background population, a local release may or may not have occurred. Similar to all statistical methods, the probability plot has limitations in cases where there is inadequate sampling and the magnitude of the release is relatively small. Thus, absence of two clear populations in the probability plots is consistent with, but not definitive proof of, the hypothesis that no releases have occurred. However, if a release has occurred within the sampled area and has been included in the samples, then the elemental concentrations

background and regional background data sets (see Table A3.4.1 for a summary of regional background data)³, and risk potential. For PCOCs or ECOIs where the process knowledge and/or spatial trends indicate that the presence of the analyte in the EU may be a result of historical site-related activities, the professional judgment discussion includes only two of the lines of evidence listed above, and it is concluded that these analytes are COCs/ECOPCs and are carried forward into risk characterization. For the other PCOCs and ECOIs that are evaluated in the professional judgment step, each of the lines of evidence listed above are included in the discussion.

For metals, Appendix A, Volume 2, Attachment 8 of the RI/FS Report provides the details of the process knowledge and spatial trend evaluations. The conclusions from these evaluations are noted in this attachment.

The following PCOCs/ECOIs are evaluated further in the professional judgment step for SEEU:

- Surface soil/surface sediment (HHRA)
 - Arsenic
 - Manganese
 - Cesium-137
 - Radium-228
- Subsurface soil/subsurface sediment (HHRA)
 - No PCOCs in subsurface soil/subsurface sediment were carried into the professional judgment step.
- Surface soil for non-PMJM receptors (ERA)
 - Aluminum
 - Boron
 - Chromium
 - Copper
 - Lithium

associated with that release are either within the background concentration range or the entire sampled population represents a release, a highly unlikely probability.

³ The regional background data set for Colorado and the bordering states was extracted from data for the western United States (Shacklette and Boerngen 1984), and is composed of data from Colorado as well as Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming. Although the Colorado and bordering states background data set is not specific to Colorado's Front Range, it is useful for the professional judgment evaluation in the absence of a robust data set for the Front Range. Colorado's Front Range has highly variable terrain that changes elevation over short distances. Consequently, numerous soil types and geologic materials are present at RFETS, and the data set for Colorado and bordering states may be more representative of these variable soil types.

- Manganese
- Molybdenum
- Nickel
- Vanadium
- Zinc
- Subsurface soil (ERA)
 - No ECOIs in subsurface soil were carried into the professional judgment evaluation step.

The following sections provide the professional judgment evaluations, by analyte and by medium, for the PCOCs/ECOIs listed above.

4.1 Aluminum

Aluminum has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if aluminum should be retained for risk characterization are summarized below.

4.1.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential to have been released into RFETS soil because of the aluminum metal inventory and presence of aluminum in waste generated during former operations. However, there are no Individual Hazardous Substance Sites (IHSSs) in SEEU. Therefore, aluminum is unlikely to be present in SEEU soil as a result of historical site-related activities.

4.1.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that aluminum concentrations in SEEU surface soil reflect variations in naturally occurring aluminum.

4.1.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log transformed data set for aluminum in surface soil within SEEU (Figure A3.4.1) suggests a single background population.

4.1.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Aluminum concentrations in SEEU surface soil range from 5,860 to 25,000 mg/kg with a mean concentration of 15,362 mg/kg and a standard deviation of 4,928 mg/kg. Aluminum concentrations in the background data set range from 4,050 to 17,100 mg/kg with a mean concentration of 10,203 mg/kg and a standard deviation of 3,256 mg/kg (Table A3.2.6). The maximum concentrations of aluminum in surface soil samples at the SEEU are elevated compared to background but the data populations overlap considerably.

Aluminum concentrations SEEU surface soil are well within the range for aluminum in soils of Colorado and the bordering states (5,000 to 100,000 mg/kg, with a mean concentration of 50,800 mg/kg and a standard deviation of 23,500 mg/kg) (Table A3.4.1).

4.1.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The MDC for aluminum in the SEEU (25,000 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (50 mg/kg). However, EPA Ecological Soil Screening Level (EcoSSL) guidance (EPA 2003) for aluminum recommends that aluminum should not be considered an ECOPC for soils at sites where the soil pH exceeds 5.5 due to its limited bioavailability in non-acidic soils. The average pH value for RFETS surface soils is 8.2. Therefore, aluminum concentrations in SEEU surface soil are unlikely to result in risk concerns for wildlife populations.

4.1.6 Conclusion

The weight of evidence presented above shows that aluminum concentrations in SEEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge, spatial distribution trend, and single data population indicative of naturally occurring aluminum. In addition, the aluminum concentrations within SEEU are well within regional background levels, and are unlikely to result in risk concerns for wildlife populations. Aluminum is not considered an ECOPC in surface soil for the SEEU and, therefore, is not further evaluated quantitatively.

4.2 Arsenic

Arsenic has concentrations statistically greater than background in surface soil/surface sediment and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if arsenic should be retained for risk characterization are summarized below.

4.2.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates arsenic is unlikely to be present in SEEU soil as a result of historical site-related activities.

4.2.2 Evaluation of Spatial Trends

Surface Soil/Surface Sediment

As discussed in Appendix A, Volume 2 Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that arsenic concentrations in SEEU surface soil/surface sediment reflect variations in naturally occurring arsenic.

4.2.3 Pattern Recognition

Surface Soil/Surface Sediment

The probability plot for the natural log transformed data set for arsenic in surface soil/surface sediment within SEEU (Figure A3.4.2) suggests a single background population ranging from 2.5 to about 9.3 mg/kg but with two samples (04F0810-005 and 04F0810-003) with anomalously elevated concentrations (12 and 23 mg/kg). The sample with the highest arsenic concentration also contains anomalous copper, manganese, molybdenum, nickel, and vanadium suggesting that it may or may not be part of the natural arsenic concentrations in this EU.

4.2.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment

Arsenic concentrations in SEEU surface soil/surface sediment range from 2.5 to 23.0 mg/kg with a mean concentration of 7.40 mg/kg and a standard deviation of 4.15 mg/kg. Arsenic concentrations in the background data set range from 0.27 to 9.6 mg/kg with a mean concentration of 3.42 mg/kg and a standard deviation of 2.55 mg/kg (Table A3.2.2). With the exception of two anomalous sample results (12.0 and 23.0 mg/kg), the range of concentrations of arsenic in the SEEU and background data set shows significant overlapping.

Arsenic concentrations SEEU surface soil/surface sediment are well within the range for arsenic in soils in Colorado and the bordering states (1.22 to 97 mg/kg, with a mean concentration of 6.9 mg/kg and a standard deviation of 7.64 mg/kg) (Table A3.4.1).

4.2.5 Risk Potential for HHRA

Surface Soil/Surface Sediment

The arsenic MDC for surface soil/surface sediment is 23.0 mg/kg and the UCL for surface soil/surface sediment is 8.9 mg/kg, which is only three to four times greater than the PRG (2.41 mg/kg). Because the PRG is based on an excess carcinogenic risk of 1E-06, the cancer risk based on the UCL concentration is less than 4E-06, and is well

within the National Contingency Plan (NCP) risk range of $1\text{E-}06$ to $1\text{E-}04$. The background UCL for arsenic in surface soil/surface sediment is 4.03 mg/kg (Appendix A, Volume 2, Attachment 9 of the RI/FS Report), which equates to a cancer risk of $2\text{E-}06$. Therefore, the excess cancer risks to the WRW from exposure to arsenic in surface soil/surface sediment in the SEEU is similar to background risk.

4.2.6 Conclusion

The weight of evidence presented above shows that arsenic concentrations in SEEU surface soil/surface sediment are not likely to be a result of historical site-related activities based on process knowledge, the spatial distribution trend and a single data population suggesting naturally occurring arsenic. The concentrations of arsenic within SEEU are well within regional background levels, and are unlikely to result in risks to humans significantly above background risks. Arsenic is not considered a COC in surface soil/surface sediment for the SEEU and, therefore, is not further evaluated quantitatively.

4.3 Boron

Boron has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if boron should be retained for risk characterization are summarized below.

4.3.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates boron is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.3.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that boron concentrations in SEEU surface soil reflect variations in naturally occurring boron.

4.3.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log transformed data set for boron in surface soil within SEEU (Figure A3.4.3) indicates a single background population. The 14 sample points are probably not sufficient to document the true range of natural boron concentrations in this EU.

4.3.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

The reported range for boron in surface soil within Colorado and the bordering states is 20 to 150 mg/kg, with a mean concentration of 27.9 mg/kg and a standard deviation of 19.7 mg/kg (Table A3.4.1). Boron concentrations reported in surface soil samples at the SEEU range from 3.70 to 8.70 mg/kg with a mean concentration of 5.95 mg/kg and a standard deviation of 1.47 mg/kg (Table A3.2.6). The range of concentrations of boron in surface soil is well within the range for boron in soils of Colorado and the bordering states.

4.3.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The MDC for boron in the SEEU (8.70 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (0.5 mg/kg). All other NOAEL ESLs were considerably greater than the MDC and ranged from 30 to 6,070 mg/kg. Site-specific background data for boron were not available, but the MDC did not exceed the low end of the range (20 mg/kg) of the background range presented in Shacklette and Boerngen (1984). This indicates the terrestrial plant NOAEL ESL (0.5 mg/kg) is well below expected background concentrations, and MDCs above the NOAEL ESL are not likely to be indicative of site-related risk to the terrestrial plant community in the SEEU. Kabata-Pendias and Pendias (1992) indicate soil with boron concentrations equal to 0.3 mg/kg is critically deficient in boron, and effects on plant reproduction would be expected. Additionally, the summary of boron toxicity in Efroymson et al. (1997) notes that the source of the 0.5-mg/kg NOAEL ESL indicates boron was toxic when added at 0.5 mg/kg to soil, but gives no indication of the boron concentration in the baseline soil before addition. The confidence placed by Efroymson et al. (1997) was low. Because no NOAEL ESLs other than the terrestrial plant NOAEL ESL are exceeded by the MDC, boron is highly unlikely to present a risk to terrestrial receptor populations in the SEEU.

4.3.6 Conclusion

The weight of evidence presented above shows that boron concentrations in SEEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge, the spatial distribution trend, and a single data population indicative of naturally occurring boron. In addition, boron concentrations in surface soil at SEEU are well within regional background levels, and are unlikely to result in risk concerns for wildlife populations. Boron is not considered an ECOPC in surface soil for the SEEU and, therefore, is not further evaluated quantitatively.

4.4 Cesium-137

Statistical background comparisons could not be performed for cesium-137 because there was a single sample result within the SEEU. Therefore, this analyte is carried forward

into the professional judgment step. The lines of evidence used to determine if cesium-137 should be retained for risk characterization are summarized below.

4.4.1 Summary of Process Knowledge

The ChemRisk Task 1 Report did not identify cesium-137 as a radionuclide used at RFETS (CDPH 1991) and no cesium-137 waste was reported to have been generated. It is unlikely that cesium-137 is present in soil at RFETS as a result of historical site-related activities.

4.4.2 Evaluation of Spatial Trends

Surface Soil/Surface Sediment

Figure A3.4.4 shows the location within SEEU where cesium-137 was sampled in surface soil/surface sediment. The cesium-137 activity was detected at 0.661 pCi/g and exceeded the cesium-137 PRG of 0.221 pCi/g. However, this activity does not exceed the background MDC of 1.80 pCi/g.

4.4.3 Pattern Recognition

Surface Soil/Surface Sediment

A probability plot for cesium-137 activity could not be generated because there was only a single sample result for the SEEU data set.

4.4.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment

There was a single sample result for cesium-137 in surface soil/surface sediment at SEEU and, therefore, a statistical background comparison could not be performed. However, the cesium-137 activity of 0.661 pCi/g did not exceed the background MDC of 1.80 pCi/g. Cesium-137 activity in the background data set range from -0.027 to 1.80 pCi/g with a mean activity of 0.692 pCi/g and a standard deviation of 0.492 pCi/g (Table A3.2.2).

4.4.5 Risk Potential for HHRA

The cesium-137 MDC for surface soil/surface sediment is 0.661 pCi/g, which is approximately one third of the background MDC of 1.8 pCi/g, but about 3 times greater than the PRG of 0.221 pCi/g. However, the PRG is based on an excess carcinogenic risk of $1\text{E-}06$; therefore, the risk to human health is well within the NCP risk range of $1\text{E-}06$ to $1\text{E-}04$. Furthermore, because cesium-137 activity in the SEEU appear to represent naturally occurring levels and because cesium-137 was not used at the site, this risk is not likely associated with any releases from RFETS.

4.4.6 Conclusion

The weight of evidence presented above shows that the single cesium-137 activity in surface soil/surface sediment in the SEEU is not a result of RFETS activities. There is no evidence of a release from potential sources inside or outside the SEEU that would impact cesium-137 activity in surface soil/surface sediment. Cesium-137 was not used or generated at RFETS and is, therefore, not considered a COC in surface soil/ surface sediment for the SEEU and not further evaluated quantitatively.

4.5 Chromium

Chromium had an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step per the CRA Methodology. The lines of evidence used to determine if chromium should be retained as an ECOPC are summarized below.

4.5.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, chromium may be present in RFETS soil as a result of historical site-related activities.

4.5.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, chromium concentrations in the SEEU appear to be variations of naturally occurring conditions. However, in order to determine if chromium should be retained as an ECOPC in SEEU, chromium is further evaluated by the other professional judgment lines of evidence, as presented below.

4.5.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log transformed data set for chromium in surface soil within SEEU (Figure A3.4.5) suggests a single background population. The 19 sample points are probably not sufficient to document the true range of natural chromium concentrations in this EU. However, the samples with the highest concentrations indicate that, at least, the upper part of the distribution may be approaching an asymptotic chromium concentration of the background population.

4.5.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Chromium was detected in each of the 19 surface soil samples collected in the SEEU. Chromium concentrations in surface soil samples at the SEEU range from 7.30 to 27.0

mg/kg, with a mean concentration of 17.0 mg/kg and a standard deviation of 5.43 mg/kg. Chromium concentrations in the background data set range from 5.50 to 16.9 mg/kg with a mean concentration of 11.2 mg/kg and a standard deviation of 2.78 mg/kg (Table A3.2.6).

Chromium concentrations reported in surface soil samples at the SEEU are well within background chromium concentrations in soils in Colorado and the bordering states, which range from 3 to 500 mg/kg, with mean concentration of 48.2 mg/kg and a standard deviation of 41 mg/kg (Table A3.4.1).

4.5.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for chromium in the SEEU (27.5 mg/kg) exceeds the NOAEL ESLs for six receptor groups, the terrestrial invertebrate (0.4 mg/kg), terrestrial plant (1 mg/kg), insectivorous mourning dove (1.34 mg/kg), herbivorous mourning dove (24.6 mg/kg), American kestrel (13.96 mg/kg), and the insectivorous deer mouse (15.9 mg/kg). With the exception of the herbivorous mourning dove ESL of 24.6 mg/kg, all of the ESLs are less than the MDC in background soils (16.9 mg/kg), indicating that they may be overly conservative because risks are not typically expected at background concentrations. The ESLs for all other non-PMJM receptors were greater than the UTL (27.5 mg/kg) and range from 281.3 to 4,173 mg/kg.

4.5.6 Conclusion

The weight of evidence presented above shows that chromium concentrations in surface soil in the SEEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the EU that would impact chromium concentrations in surface soil. In addition, the MDC for chromium is below the lowest reported value of the Colorado and the bordering states data set. Chromium is not considered an ECOPC in surface soil for the SEEU and is not further evaluated quantitatively.

4.6 Copper

Copper had an EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step in accordance with the CRA Methodology. The lines of evidence used to determine if copper should be retained as an ECOPC are summarized below.

4.6.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the potential for copper to be an ECOPC in the SEEU is low due to an exceedingly small inventory, and limited identification as a constituent in wastes

generated at RFETS and localized documented historical source areas remote from the SEEU.

4.6.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, copper concentrations in the SEEU appear to be variations of naturally occurring conditions.

4.6.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log transformed data set for copper in surface soil within SEEU (Figure A3.4.6) indicates a single background population ranging from 7.8 to about 19 mg/kg but with one sample (04F0810-003) containing a higher copper concentration of 25 mg/kg. This sample is also anomalously high for manganese, molybdenum, nickel, vanadium and arsenic. Therefore it may or may not be part of the natural copper concentrations in this EU.

4.6.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Copper was detected in each of the 19 surface soil samples collected in the SEEU. Copper concentrations in surface soil samples at the SEEU range from 7.80 to 25.0 mg/kg, with a mean concentration of 15.2 mg/kg and a standard deviation of 3.83 mg/kg. Copper concentrations in the background data set range from 5.20 to 16.0 mg/kg, with a mean concentration of 13.0 mg/kg and a standard deviation of 2.58 mg/kg (Table A3.2.6). Concentrations of copper in SEEU surface soil are higher than RFETS background concentrations, but lie within the copper background concentrations in surface soils in Colorado and bordering states, which range from 2 to 200 mg/kg, with a mean of 23.1 mg/kg and a standard deviation of 17.7 mg/kg (Table A3.4.1).

4.6.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for copper in SEEU (22.7 mg/kg) exceeds the NOAEL ESL for only one receptor, the insectivorous mourning dove (8.25 mg/kg). The mean background concentration also exceeds the NOAEL ESL for the insectivorous mourning dove. Because the ESL is within the range of background concentrations, risk is not expected to be at a level of concern. This indicates that this ESL may be overly conservative for use in the ECOPC identification process. Given the conservative nature of this ESL and the similarity between the SEEU and background data sets, it is highly unlikely that there would be population risks associated with these relatively low levels of copper.

4.6.6 Conclusion

The weight of evidence presented above shows that copper concentrations in surface soil in the SEEU are not a result of RFETS activities, but are representative of naturally occurring concentrations. Copper is not considered an ECOPC in surface soil for the SEEU; therefore, is not further evaluated quantitatively.

4.7 Lithium

Lithium had an EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step per the CRA Methodology. The lines of evidence used to determine if lithium should be retained as an ECOPC are summarized below.

4.7.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, lithium may be present in RFETS soil as a result of historical site-related activities.

4.7.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, lithium concentrations in the SEEU appear to be variations of naturally occurring conditions.

4.7.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log transformed data set for lithium in surface soil within SEEU (Figure A3.4.7) indicates a single background population.

4.7.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Lithium was detected in 15 of the 16 surface soil samples collected at the SEEU. Lithium concentrations in surface soil samples at the SEEU range from 5.20 to 23.0 mg/kg, with a mean concentration of 13.3 mg/kg and a standard deviation of 5.29 mg/kg. Lithium concentrations in the background data set range from 4.80 to 11.6 mg/kg with a mean concentration of 7.66 mg/kg and a standard deviation of 1.89 mg/kg (Table A3.2.6). The maximum concentrations of lithium in surface soil samples at the SEEU are elevated compared to background but the data populations do overlap.

Lithium concentrations reported in surface soil samples at the SEEU are well within the lithium background concentrations in surface soils in Colorado and the bordering states,

which range from 5 to 130 mg/kg with mean concentration of 25.3 mg/kg and a standard deviation of 14.4 mg/kg (Table A3.4.1).

4.7.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The MDC for lithium in the SEEU (23 mg/kg) exceeds the NOAEL ESL for only one receptor, terrestrial plants (2 mg/kg), which is lower than the minimum detection of lithium in background surface soils (4.8 mg/kg). None of the NOAEL ESLs for mammalian receptors are exceeded by the MDC. The authors of the document from which the lithium NOAEL ESL was selected (Efroymson et al. 1997) placed a low confidence rating on the value. Lithium concentrations greater than the background in the SEEU are likely due to spatial variations of naturally occurring lithium in alluvial materials and are below available ESLs for vertebrate receptors. Therefore, concentrations of lithium are highly unlikely to present risks to wildlife populations in the SEEU.

4.7.6 Conclusion

The weight of evidence presented above shows that lithium concentrations in surface soil in the SEEU are not a result of RFETS activities, but are representative of naturally occurring concentrations. Concentrations of lithium detected in SEEU surface soils appear to be somewhat skewed versus RFETS background concentrations, but are well within the low end of the range in soils within Colorado and the bordering states. Lithium is not considered an ECOPC in surface soil for the SEEU; therefore, it is not further evaluated quantitatively.

4.8 Manganese

Manganese had concentrations statistically greater than background in surface soil/surface sediment and also had an EPC in surface soil (for non-PMJM receptors) greater than the tESL. Consequently, manganese was carried forward to the professional judgment step per the CRA Methodology. The lines of evidence used to determine if manganese should be retained as a COC in surface soil/surface sediment and an ECOPC in surface soil are summarized below.

4.8.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, manganese is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.8.2 Evaluation of Spatial Trends

Surface Soil/Surface Sediment

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, manganese concentrations in surface soil/surface sediment in the SEEU appear to be variations of naturally occurring conditions.

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, manganese concentrations in surface soil in the SEEU appear to be variations of naturally occurring conditions.

4.8.3 Pattern Recognition

Surface Soil/Surface Sediment and Surface Soil

The probability plot for the natural log transformed data set for manganese in surface soil/surface sediment in SEEU (Figure A3.4.8) indicates a background population ranging from about 220 to 600 mg/kg but with a single sample representing an anomalously elevated concentration (04F0810-003) of 1,300 mg/kg. However this highest sample concentration is also anomalously elevated in copper, molybdenum, nickel, vanadium and arsenic suggesting that it may or may be not part of the natural manganese concentrations in this EU.

Surface Soil (Non-PMJM)

The probability plot for the natural log transformed data set for manganese in surface soil in SEEU (Figure A3.4.9) indicates a background population ranging from about 220 to 600 mg/kg but with a single sample representing an anomalously elevated concentration (04F0810-003) of 1,300 mg/kg and an anomalously low concentration (04F1269-005) of 55 mg/kg. The 17 samples forming the background population probably do not represent the full concentration range of the background population. However the highest sample concentration is also anomalously elevated in copper, molybdenum, nickel, vanadium and arsenic suggesting that it may or may be not part of the natural manganese concentrations in this EU.

4.8.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment

Manganese was detected in each of the 22 surface soil/surface sediment samples collected in the SEEU. Manganese concentrations in surface soil/surface sediment samples at the SEEU range from 55.0 to 1,300 mg/kg, with a mean concentration of 386 mg/kg and a standard deviation of 237 mg/kg. Background manganese concentrations range from 9.0 to 1,280 mg/kg, with a mean concentration of 241 mg/kg and a standard deviation of 189 mg/kg (Table A3.2.2). Concentrations of manganese in the SEEU surface soil/surface sediment are higher than RFETS background concentrations, but within the range of surface soils in Colorado and the bordering states background

concentrations, which range from 70 to 2,000 mg/kg, with a mean concentration of 414 mg/kg and a standard deviation of 272 mg/kg (Table A3.4.1).

Surface Soil (Non-PMJM)

Manganese was detected in each of the 19 surface soil samples collected in the SEEU. Manganese concentrations in surface soil samples at the SEEU range from 55 to 1,300 mg/kg, with a mean concentration of 392 mg/kg and a standard deviation of 247 mg/kg. Manganese concentrations in the background range from 129 to 357 mg/kg, with a mean concentration of 237 mg/kg and a standard deviation of 63.9 mg/kg (Table A3.2.6). 8 of the 19 surface soil samples are higher than RFETS background concentrations.

Manganese concentrations reported in surface soil samples at the SEEU are well within background manganese concentrations in soils of Colorado and the bordering states, which range from 70 to 2,000 mg/kg with mean concentration of 414 mg/kg and a standard deviation of 272 mg/kg (Table A3.4.1).

4.8.5 Risk Potential for HHRA

Surface Soil/Surface Sediment

The manganese MDC for surface soil/surface sediment is 1,300 mg/kg and the UCL for surface soil/surface sediment is 607 mg/kg, which is only approximately 50 percent greater than the PRG (419 mg/kg). The PRG is based on a Hazard Quotient (HQ) of 0.1, therefore, the risk to human health is well below the EPA guideline of an HQ of 1. Furthermore, because manganese concentrations in the SEEU appear to represent naturally occurring manganese, this risk is unassociated with manganese releases from RFETS.

4.8.6 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for manganese in the SEEU (1,300 mg/kg) exceeds the NOAEL ESLs for three group receptors: terrestrial plants (500 mg/kg), herbivorous mourning dove (1,032 mg/kg), and herbivorous deer mouse (486 mg/kg). NOAEL ESLs for all other non-PMJM receptors were greater than the MDC and range from 1,519 to 19,115 mg/kg.

4.8.7 Conclusion

The weight of evidence presented above shows that manganese concentrations in surface soil/surface sediment and in surface soil in the SEEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the EU that would impact manganese concentrations in the soil. Manganese is not considered a COC or an ECOPC for the SEEU and, therefore, is not further evaluated quantitatively.

4.9 Molybdenum

Molybdenum had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step per the CRA Methodology. The lines of evidence used to determine if molybdenum should be retained as a ECOPC are summarized below.

4.9.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, molybdenum is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.9.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, molybdenum concentrations in the SEEU appear to be variations of naturally occurring conditions.

4.9.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log transformed data set for molybdenum in surface soil in SEEU (Figure A3.4.10) indicate a background population ranging from 0.43 to about 1.20 mg/kg but with four anomalously high concentrations ranging from 1.9 to 2.35 mg/kg. These four samples are 04F0810-003 (1.90 mg/kg), SS01164ST (2.15 mg/kg), SS01110ST (2.30 mg/kg) and SS01109ST (2.35 mg/kg). Given the limited total number of molybdenum analyses (18) and limited range of these molybdenum concentrations, the background population may well include these four samples if more samples were collected and analyzed.

4.9.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Molybdenum was detected in 78 percent of the 18 surface soil samples collected in the SEEU. Molybdenum concentrations in surface soil samples at the SEEU range from 0.610 to 1.90 mg/kg, with a mean concentration of 1.14 mg/kg and a standard deviation of 0.605 mg/kg (Table A3.2.6). Molybdenum concentrations in the RFETS background data set were not available, but the SEEU molybdenum concentrations were within the range of Colorado and bordering states background concentrations, which range from 3 to 7 mg/kg with a mean concentration of 1.59 mg/kg and a standard deviation of 0.522 mg/kg (Table A3.4.1).

4.9.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The molybdenum UTL in the SEEU (2.64 mg/kg) exceeded the NOAEL ESL for two receptor groups, the insectivorous deer mouse receptor (1.90 mg/kg) and terrestrial plant receptors (2.0 mg/kg). The NOAEL ESLs for all other non-PMJM receptors were greater than the MDC and range from 8.68 to 275 mg/kg. The molybdenum UTL of 2.64 mg/kg is greater than the MDC of 1.90 mg/kg because the UTL calculation takes into consideration half of the nondetected concentrations, some of which may have had high detection limits. Molybdenum background concentrations in Colorado and bordering states range from 3 to 7 mg/kg, suggesting that the ESL for insectivorous deer mouse receptor (1.90 mg/kg) and terrestrial plant receptors (2.0 mg/kg) may be overly conservative for screening purposes.

4.9.6 Conclusion

The weight of evidence presented above shows that molybdenum concentrations in surface soil in the SEEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the EU that would impact molybdenum concentrations in surface soil. In addition, the MDC for molybdenum is below the lowest reported value of the Colorado and the bordering states data set. Molybdenum is not considered an ECOPC in surface soil for the SEEU and is not further evaluated quantitatively.

4.10 Nickel

Nickel had an EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step per the CRA Methodology. The lines of evidence used to determine if nickel should be retained as an ECOPC are summarized below.

4.10.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, nickel may be present in RFETS soil as a result of historical site-related activities.

4.10.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, nickel concentrations in the SEEU appear to be variations of naturally occurring conditions.

4.10.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log transformed data set for nickel in surface soil in SEEU (Figure A3.4.11) indicates a background population ranging from about 9.3 to 22 mg/kg but with a single sample (04F0810-003) with a elevated concentration of 35 mg/kg. The 18 samples forming the background population probably do not represent the full concentration range of the background population. However the highest sample concentration is also anomalously elevated in copper, manganese, molybdenum, vanadium and arsenic suggesting that it may or may not be part of the natural nickel concentrations in this EU.

4.10.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Nickel was detected in each of the 19 surface soil samples collected in the SEEU. Nickel concentrations in surface soil samples at the SEEU range from 9.30 to 35.0 mg/kg, with a mean concentration of 16.3 mg/kg and a standard deviation of 6.03 mg/kg. Nickel concentrations in the background data set range from 3.80 to 14.0 mg/kg, with a mean of 9.60 mg/kg and a standard deviation of 2.59 mg/kg (Table A3.2.6). The reported range for nickel in surface soil within Colorado and the bordering states is 5 to 700 mg/kg with a mean concentration of 18.8 mg/kg and a standard deviation of 39.8 mg/kg (Table A3.4.1). The range of concentrations of nickel in surface soil within SEEU is at the low end of the range for nickel in soils of Colorado and the bordering states.

4.10.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for nickel (35 mg/kg) exceeds NOAEL ESLs for seven receptor groups: the insectivorous mourning dove (1.24 mg/kg), insectivorous deer mouse (0.43 mg/kg), herbivorous deer mouse (16.4 mg/kg), insectivorous coyote (1.9 mg/kg), the generalist coyote (6.0 mg/kg), and the terrestrial plants. All of these ESLs except the herbivorous deer mouse and terrestrial plants, are less than the MDC in background soils (14 mg/kg), indicating that they may be overly conservative because risks are not typically expected at background concentrations.

4.10.6 Conclusion

The weight of evidence presented above shows that nickel concentrations in surface soil in the SEEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the EU that would impact nickel concentrations in surface soil. In addition, the range of concentrations of nickel in surface soil is within the range for nickel in soils of

Colorado and the bordering states. Nickel is not considered an ECOPC in surface soil for the SEEU and is not further evaluated quantitatively.

4.11 Radium-228

A background comparison analysis could not be performed for radium-228 in surface soil/surface sediment in the SEEU because there was a single sample location within the EU. However, because the single radium activity (considered MDC) and its UCL exceeded the PRG, radium-228 was carried forward to the professional judgment step per the CRA Methodology. The lines of evidence used to determine if radium-228 should be retained as a COC in surface soil/surface sediment are summarized below.

4.11.1 Summary of Process Knowledge

The potential for radium-228 to be a COC in the SEEU is very low because it was not used at RFETS. The ChemRisk Task 1 Report did not identify radium-228 as a radionuclide used at RFETS (CDPH 1991a) and no radium-228 waste was reported to have been generated.

4.11.2 Evaluation of Spatial Trends

Surface Soil/Surface Sediment

Figure A3.4.12 shows the single location where radium-228 was sampled within SEEU. The single radium-228 concentration of 1.59 pCi/g exceeded the PRG of 0.111 pCi/g. This radium-228 concentration is similar to activities throughout the site and is less than that site background MDC of 4.10 pCi/g.

4.11.3 Pattern Recognition

Surface Soil/Surface Sediment

A probability plot for radium-228 activities in surface soil/surface sediment could not be generated because there was a single sample result for the SEEU data set.

4.11.4 Comparison to RFETS Background and Other Background Data Sets

There was a single sample result for radium-228 in surface soil/surface sediment at SEEU and, therefore, a statistical background comparison could not be performed. The radium-228 surface soil/surface sediment of 1.59 pCi/g does not exceed the site background MDC of 4.10 pCi/g. The site background activities for radium-228 in surface soil/surface sediment range from 0.200 pCi/g to 4.10 pCi/g, with a mean of 1.60 pCi/g (Table A3.2.2). Therefore, the concentration of radium-228 in surface soil/surface sediment at SEEU is well within site background activities.

4.11.5 Risk Potential for HHRA

Surface Soil/Surface Sediment

The radium-228 MDC for surface soil/surface sediment is 1.59 pCi/g and the PRG is 0.111 pCi/g. Site background activities range from 0.200 to 4.10 pCi/g, which indicates that all site background concentrations for radium-228 exceed the PRG. Since the PRG is based on a IE-06 risk, the risk to human health in the SEEU from radium-228 is within the NCP risk range of IE-06 to IE-04. Furthermore, because radium-228 activities in the SEEU appear to represent naturally occurring and because radium-228 was not used at the site, this risk is not likely associated with any releases from RFETS.

4.11.6 Conclusion

The weight of evidence presented above shows that the single radium-228 activity in surface soil/surface sediment in the SEEU is not a result of RFETS activities. There is no evidence of a source or release from areas inside or outside the SEEU that would impact radium-228 activities in surface soil/surface sediment. In addition, the radium-228 activities in surface soil/surface. In addition, the radium-228 concentration in surface soil/surface sediment sample at the SEEU is much lower than the site background MDC. Radium-228 was not used or generated at RFETS and is, therefore, not considered a COC in surface soil/ surface sediment for the SEEU and not further evaluated quantitatively.

4.12 Vanadium

Vanadium had an EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step. The lines of evidence used to determine if vanadium should be retained as an ECOPC are summarized below.

4.12.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, vanadium is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.12.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, vanadium concentrations in the SEEU appear to be variations of naturally occurring conditions.

4.12.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log transformed data set for vanadium in surface soil in SEEU (Figure A3.4.13) indicates a background population ranging from about 22.5 to

78 mg/kg but with a single sample (04F0810-003) with a high concentration of 140 mg/kg. The 18 samples forming the background population probably do not represent the full concentration range of the background population. However, the highest sample concentration is also anomalously high in copper, manganese, molybdenum, nickel and arsenic suggesting that it may or may not be part of the natural manganese concentrations in this EU.

4.12.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Vanadium was detected in each of the 19 surface soil samples collected in the SEEU. Vanadium concentrations in surface soil samples at the SEEU range from 22.5 to 140 mg/kg, with a mean concentration of 50.5 mg/kg and a standard deviation of 26.7 mg/kg. Vanadium concentrations in the RFETS background data set range from 10.8 to 45.8 mg/kg, with a mean of 27.7 mg/kg and a standard deviation of 7.68 mg/kg (Table A3.2.6). The reported range for vanadium in surface soil within Colorado and the bordering states is 7 to 300 mg/kg with a mean concentration of 73 mg/kg and a standard deviation of 41.7 mg/kg (Table A3.4.1). Vanadium concentrations reported in surface soil samples in the SEEU are well within the range for vanadium in soils of Colorado and the bordering states.

4.12.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for vanadium in the SEEU (140 mg/kg) exceeded the NOAEL ESLs for five receptor groups: terrestrial plants (2 mg/kg), the herbivorous deer mouse (63.7 mg/kg), the insectivorous deer mouse receptor (29.9 mg/kg), the prairie dog (83.5 mg/kg), and the insectivorous coyote (121 mg/kg). The plant NOAEL ESL is lower than all background concentrations of vanadium, indicating that they may be overly conservative because risks are not typically expected at background concentrations. The ESL for the insectivorous deer mouse is also less than the MDC in background soils (45.8 mg/kg) and approximately equal to the mean background concentration (27.7 mg/kg).

4.12.6 Conclusion

The weight of evidence presented above shows that vanadium concentrations in surface soil in the SEEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the EU that would impact vanadium concentrations in surface soil. Vanadium is not considered an ECOPC in surface soil for the SEEU and, therefore, is not further evaluated quantitatively.

4.13 Zinc

Zinc had an EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step per the CRA Methodology. The lines of evidence used to determine if zinc should be retained as an ECOPC are summarized below.

4.13.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, zinc is unlikely to be present in RFETS soil as a result of historical site-related activities..

4.13.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

Based on the spatial trend evaluation detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, zinc concentrations in the SEEU appear to be variations of naturally occurring conditions.

4.13.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log transformed data set for zinc in surface soil in SEEU (Figure A3.4.14) indicates a single background population ranging from about 46 to 71 mg/kg but with three anomalously low zinc concentrations. The four anomalously low concentration samples (and their zinc concentrations) include 04F1269-005 (18 mg/kg), SS50082.AS (23.1 mg/kg) and 04F1269-006 (37 mg/kg). These four samples may represent part of the background population but more samples would need to be collected and analyzed to confirm this supposition.

4.13.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

The reported range for zinc in surface soil within Colorado and the bordering states is 10 to 2,080 mg/kg with a mean concentration of 72.4 mg/kg and a standard deviation of 159 mg/kg (Table 3.4.1). Zinc concentrations reported in surface soil samples at the SEEU are 18.0 to 71 mg/kg with a mean concentration of 53.6 mg/kg and a standard deviation of 15.1 mg/kg (Table A3.2.6). Zinc concentrations in the RFETS background data set range from 21.1 to 75.9 mg/kg, with a mean of 49.8 mg/kg and a standard deviation of 12.2 mg/kg (Table A3.2.6). The range of concentrations of zinc in surface soil within SEEU overlaps with the site background data set and fall within the lower range for zinc in soils of Colorado and the bordering states.

4.13.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for zinc in the SEEU (71.0 mg/kg) exceeds the NOAEL ESL for three receptor groups, terrestrial plants (50 mg/kg), mourning dove insectivore (0.65 mg/kg) and deer mouse insectivore (5.29 mg/kg). All other NOAEL ESLs were greater than the MDC and ranged from 171 to 16,489 mg/kg. All of these ESLs are less than the MDC in background soils (75.9 mg/kg), indicating that they may be overly conservative because risks are not typically expected at background concentrations.

4.13.6 Conclusion

The weight of evidence presented above shows that zinc concentrations in surface soil in the SEEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the EU that would impact zinc concentrations in surface soil. In addition, the zinc MDC in surface soil at SEEU does not exceed the site background MDC and is within the lower range for zinc in soils of Colorado and the bordering states. Zinc is not considered an ECOPC in surface soil for the SEEU and is not further evaluated quantitatively.

5.0 REFERENCES

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TABLES

Table A3.2.1
Statistical Distribution and Comparison to Background for SEEU Surface Soil/Surface Sediment

| Analyte | Unit | Statistical Distribution Testing Results | | | | | | Background Comparison | | |
|------------|-------|--|------------------------------------|-------------|--|------------------------------------|-------------|-----------------------|----------|--|
| | | Background | | | SEEU (Excluding Background Samples) | | | Test | 1- p | Statistically Greater than Background? |
| | | Total No. of Samples | Distribution Recommended by ProUCL | Detects (%) | Total No. of Samples | Distribution Recommended by ProUCL | Detects (%) | | | |
| Arsenic | mg/kg | 73 | GAMMA | 91.8 | 22 | GAMMA | 100.00 | WRS | 1.28E-06 | Yes |
| Manganese | mg/kg | 73 | GAMMA | 100.0 | 22 | NONPARAMETRIC | 100.00 | WRS | 5.28E-05 | Yes |
| Cesium-137 | pCi/g | 105 | NONPARAMETRIC | 100.0 | 1 | 0 | 100.00 | WRS | N/A | N/A |
| Radium-228 | pCi/g | 40 | GAMMA | 100.0 | 1 | 0 | 100.00 | WRS | N/A | N/A |

Test: WRS - Wilcoxon Rank Sum, t-Test_N - Student's t-test using normal data, t-Test-LN - Student's t-test using log-transformed data,

N/A = not applicable; site and/or background detection frequency less than 20 percent.

Bold = Analyte retained for further consideration in the next COC selection step.

Table A3.2.2
Summary Statistics for SEEU Surface Soil/Surface Sediment*

| Analyte | Unit | Background | | | | | SEEU (Excluding Background Samples) | | | | |
|------------|-------|----------------------------|--------------------------------------|--------------------------------------|-----------------------|-----------------------|--|--------------------------------------|--------------------------------------|-----------------------|-----------------------|
| | | Total No. of Samples | Minimum Detected Concentration | Maximum Detected Concentration | Mean Concentration | Standard Deviation | Total No. of Samples | Minimum Detected Concentration | Maximum Detected Concentration | Mean Concentration | Standard Deviation |
| Arsenic | mg/kg | 73 | 0.270 | 9.60 | 3.42 | 2.55 | 22 | 2.50 | 23.0 | 7.40 | 4.15 |
| Manganese | mg/kg | 73 | 9.00 | 1,280 | 241 | 189 | 22 | 55.0 | 1,300 | 386 | 237 |
| Cesium-137 | pCi/g | 105 | -0.027 | 1.80 | 0.692 | 0.492 | 1 | 0.661 | 0.661 | 0.661 | N/A |
| Radium-228 | pCi/g | 40 | 0.200 | 4.10 | 1.60 | 0.799 | 1 | 1.59 | 1.59 | 1.59 | N/A |

* Statistics are computed using one-half the reported value for nondetects.

N/A = Not applicable or not available.

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Table A3.2.3
Statistical Distribution and Comparison to Background for SEEU Subsurface Soil/Subsurface Sediment

| Analyte | Units | Statistical Distribution/Testing Results | | | | | | Background Comparison | | |
|------------|-------|--|------------------------------------|-------------|--|------------------------------------|-------------|-----------------------|-------|--|
| | | Background | | | SEEU (Excluding Background Samples) | | | Test | 1 - p | Statistically Greater than Background? |
| | | Total No. of Samples | Distribution Recommended by ProUCL | Detects (%) | Total No. of Samples | Distribution Recommended by ProUCL | Detects (%) | | | |
| Radium-228 | pCi/g | 31 | GAMMA | 100.0 | 4 | NORMAL | 100.00 | WRS | 0.767 | No |

Test: WRS - Wilcoxon Rank Sum, t-Test_N - Student's t-test using normal data, t-Test-LN - Student's t-test using log-transformed data

Table A3.2.4
Summary Statistics for SEEU Subsurface Soil/Subsurface Sediment^a

| Analyte | Unit | Background | | | | | SEEU (Excluding Background Samples) | | | | |
|------------|-------|----------------------------|--------------------------------------|--------------------------------------|-----------------------|-----------------------|--|--------------------------------------|--------------------------------------|-----------------------|-----------------------|
| | | Total No. of Samples | Minimum Detected Concentration | Maximum Detected Concentration | Mean Concentration | Standard Deviation | Total No. of Samples | Minimum Detected Concentration | Maximum Detected Concentration | Mean Concentration | Standard Deviation |
| Radium-228 | pCi/g | 31 | 1.00 | 2.10 | 1.45 | 0.320 | 4 | 0.191 | 2.01 | 0.999 | 0.897 |

^a Statistics are computed using one-half the reported value for nondetects.

Table A3.2.5
Statistical Distribution and Comparison to Background for SEEU Surface Soil^a

| Analyte | Unit | Statistical Distribution Testing Results | | | | | | Background | | |
|------------|-------|--|------------------------------------|-------------|----------------------|------------------------------------|-------------|------------|----------|--|
| | | Background | | | SEEU | | | Test | 1 - p | Statistically Greater than Background? |
| | | Total No. of Samples | Distribution Recommended by ProUCL | Detects (%) | Total No. of Samples | Distribution Recommended by ProUCL | Detects (%) | | | |
| Inorganics | | | | | | | | | | |
| Aluminum | mg/kg | 20 | NORMAL | 100 | 19 | NORMAL | 100 | t-Test | 2.09E-04 | Yes |
| Arsenic | mg/kg | 20 | NORMAL | 100 | 19 | GAMMA | 100 | WRS | 0.177 | No |
| Barium | mg/kg | 20 | NORMAL | 100 | 19 | NORMAL | 100 | t-Test | 3.17E-04 | Yes |
| Boron | mg/kg | N/A | N/A | N/A | 14 | NORMAL | 100 | N/A | N/A | N/A |
| Cadmium | mg/kg | 20 | NONPARAMETRIC | 65 | 19 | GAMMA | 68.4 | WRS | 0.997 | No |
| Chromium | mg/kg | 20 | NORMAL | 100 | 19 | NORMAL | 100 | t-Test | 8.45E-05 | Yes |
| Copper | mg/kg | 20 | NONPARAMETRIC | 100 | 19 | NORMAL | 100 | WRS | 0.020 | Yes |
| Lead | mg/kg | 20 | NORMAL | 100 | 19 | NORMAL | 100 | t-Test | 0.999 | No |
| Lithium | mg/kg | 20 | NORMAL | 100 | 16 | NORMAL | 93.8 | t-Test | 4.11E-05 | Yes |
| Manganese | mg/kg | 20 | NORMAL | 100 | 19 | NONPARAMETRIC | 100 | WRS | 2.10E-04 | Yes |
| Mercury | mg/kg | 20 | NONPARAMETRIC | 40 | 16 | GAMMA | 25 | WRS | 1.000 | No |
| Molybdenum | mg/kg | 20 | NORMAL | 0 | 18 | LOGNORMAL | 77.8 | N/A | N/A | N/A |
| Nickel | mg/kg | 20 | NORMAL | 100 | 19 | GAMMA | 100 | WRS | 2.91E-05 | Yes |
| Vanadium | mg/kg | 20 | NORMAL | 100 | 19 | GAMMA | 100 | WRS | 9.28E-05 | Yes |
| Zinc | mg/kg | 20 | NORMAL | 100 | 19 | NONPARAMETRIC | 100 | WRS | 0.089 | Yes |

^a EU data used for background comparisons do not include data from background locations.

N/A - not applicable; background data not available or not detected. (Statistical comparisons to background cannot be performed. The analyte is retained as an ECOI for further evaluation).

Bold = Analyte retained for further consideration in the next COC selection step.

Table A3.2.6
Summary Statistics For SEEU Surface Soil*

| Analyte | Units | Background | | | | | SEEU (excluding background samples) | | | | |
|------------|-------|------------------|--------------------------------------|--------------------------------------|--------|-----------------------|--|--------------------------------------|--------------------------------------|--------|-----------------------|
| | | Total Samples | Minimum Detected Concentration | Maximum Detected Concentration | Mean | Standard Deviation | Total Samples | Minimum Detected Concentration | Maximum Detected Concentration | Mean | Standard Deviation |
| Aluminum | mg/kg | 20 | 4.050 | 17.100 | 10.203 | 3.256 | 19 | 5.860 | 25.000 | 15.362 | 4.928 |
| Arsenic | mg/kg | 20 | 2.30 | 9.60 | 6.09 | 2.00 | 19 | 2.50 | 23.0 | 7.43 | 4.41 |
| Barium | mg/kg | 20 | 45.7 | 134 | 102 | 19.4 | 19 | 57.0 | 210 | 141 | 41.4 |
| Boron | mg/kg | N/A | N/A | N/A | N/A | N/A | 14 | 3.70 | 8.70 | 5.95 | 1.47 |
| Cadmium | mg/kg | 20 | 0.670 | 2.30 | 0.708 | 0.455 | 19 | 0.120 | 1.00 | 0.356 | 0.207 |
| Chromium | mg/kg | 20 | 5.50 | 16.9 | 11.2 | 2.78 | 19 | 7.30 | 27.0 | 17.0 | 5.43 |
| Copper | mg/kg | 20 | 5.20 | 16.0 | 13.0 | 2.58 | 19 | 7.80 | 25.0 | 15.2 | 3.83 |
| Lead | mg/kg | 20 | 8.60 | 53.3 | 33.5 | 10.5 | 19 | 4.80 | 37.0 | 23.9 | 6.63 |
| Lithium | mg/kg | 20 | 4.80 | 11.6 | 7.66 | 1.89 | 16 | 5.20 | 23.0 | 13.3 | 5.29 |
| Manganese | mg/kg | 20 | 129 | 357 | 237 | 63.9 | 19 | 55.0 | 1,300 | 392 | 247 |
| Mercury | mg/kg | 20 | 0.090 | 0.120 | 0.072 | 0.031 | 16 | 0.014 | 0.021 | 0.014 | 0.012 |
| Molybdenum | mg/kg | 20 | N/A | N/A | 0.573 | 0.184 | 18 | 0.610 | 1.90 | 1.14 | 0.605 |
| Nickel | mg/kg | 20 | 3.80 | 14.0 | 9.60 | 2.59 | 19 | 9.30 | 35.0 | 16.3 | 6.03 |
| Vanadium | mg/kg | 20 | 10.8 | 45.8 | 27.7 | 7.68 | 19 | 22.5 | 140 | 50.5 | 26.7 |
| Zinc | mg/kg | 20 | 21.1 | 75.9 | 49.8 | 12.2 | 19 | 18.0 | 71.0 | 53.6 | 15.1 |

* Statistics are computed using one-half the reported value for nondetects.

N/A - not applicable; background data not available or not detected.

Table A3.2.7
Statistical Distribution and Comparison to Background for SEEU Subsurface Soil

| Analyte | Unit | Statistical Distribution Testing Results | | | | | | Background | | |
|---------|-------|--|------------------------------------|-------------|----------------------|------------------------------------|-------------|------------|-------|--|
| | | Background | | | SEEU* | | | Test | 1 - p | Statistically Greater than Background? |
| | | Total No. of Samples | Distribution Recommended by ProUCL | Detects (%) | Total No. of Samples | Distribution Recommended by ProUCL | Detects (%) | | | |
| Arsenic | mg/kg | 45 | NONPARAMETRIC | 93 | 6 | NORMAL | 100 | WRS | 0.045 | Yes |

* SEEU data for background comparison do not include any background locations.

Bold = Analyte retained for further consideration in the next COC selection step.

Table A3.2.8
Summary Statistics For SEEU Subsurface Soil*

| Analyte | Units | Background | | | | | SEEU (excluding background samples) | | | | |
|---------|-------|------------------|--------------------------------------|--------------------------------------|------|-----------------------|--|--------------------------------------|--------------------------------------|------|-----------------------|
| | | Total Samples | Minimum Detected Concentration | Maximum Detected Concentration | Mean | Standard Deviation | Total Samples | Minimum Detected Concentration | Maximum Detected Concentration | Mean | Standard Deviation |
| Arsenic | mg/kg | 45 | 1.70 | 41.8 | 5.48 | 6.02 | 6 | 2.70 | 19.1 | 8.10 | 5.74 |

* Statistics are computed using one-half the reported value for nondetects.

Table A3.4.1
Summary of Element Concentration in Colorado and Bordering States Soil

| Analyte | Total Number of Results | Number of Qualified Results | Number of Nondetects | Detection Frequency (%) | Minimum Detected Value (mg/kg) | Maximum Detected Value (mg/kg) | Range of Detected Values (mg/kg) | Average Detected Value (mg/kg) | Standard Deviation (mg/kg) |
|------------|-------------------------|-----------------------------|----------------------|-------------------------|--------------------------------|--------------------------------|----------------------------------|--------------------------------|----------------------------|
| Aluminum | 335 | 32 | | 100% | 10.0 | 100,000 | 10 - 100,000 | 45,900 | 26,900 |
| Antimony | 84 | | 71 | 15% | 1.04 | 2.53 | 1.038 - 2.531 | 0.647 | 0.378 |
| Arsenic | 307 | | 2 | 99% | 1.22 | 97.0 | 1.224 - 97 | 6.90 | 7.64 |
| Barium | 342 | | | 100% | 100 | 3,000 | 100 - 3,000 | 642 | 330 |
| Beryllium | 342 | | 219 | 36% | 1.00 | 7.00 | 1 - 7 | 0.991 | 0.876 |
| Boron | 342 | | 114 | 67% | 20.0 | 150 | 20 - 150 | 27.9 | 19.7 |
| Bromine | 85 | | 42 | 51% | 0.504 | 3.52 | 0.5038 - 3.522 | 0.681 | 0.599 |
| Calcium | 342 | | | 100% | 0.055 | 32.0 | 0.055 - 32 | 3.09 | 4.13 |
| Carbon | 85 | | | 100% | 0.300 | 10.0 | 0.3 - 10 | 2.18 | 1.92 |
| Cerium | 291 | | 244 | 16% | 150 | 300 | 150 - 300 | 90.0 | 38.4 |
| Chromium | 342 | | | 100% | 3.00 | 500 | 3 - 500 | 48.2 | 41.0 |
| Cobalt | 342 | | 39 | 89% | 3.00 | 30.0 | 3 - 30 | 8.09 | 5.03 |
| Copper | 342 | | | 100% | 2.00 | 200 | 2 - 200 | 23.1 | 17.7 |
| Fluorine | 264 | | 7 | 97% | 10.0 | 1,900 | 10 - 1,900 | 394 | 261 |
| Gallium | 340 | | 3 | 99% | 5.00 | 50.0 | 5 - 50 | 18.3 | 8.90 |
| Germanium | 85 | | | 100% | 0.578 | 2.15 | 0.5777 - 2.146 | 1.18 | 0.316 |
| Iodine | 85 | | 18 | 79% | 0.516 | 3.49 | 0.516 - 3.487 | 1.07 | 0.708 |
| Iron | 342 | | | 100% | 3,000 | 100,000 | 3,000 - 100,000 | 21,100 | 13,500 |
| Lanthanum | 341 | | 115 | 66% | 30.0 | 200 | 30 - 200 | 39.8 | 28.8 |
| Lead | 342 | | 25 | 93% | 10.0 | 700 | 10 - 700 | 24.8 | 41.5 |
| Lithium | 307 | | | 100% | 5.00 | 130 | 5 - 130 | 25.3 | 14.4 |
| Magnesium | 342 | 1 | | 100% | 300 | 100,000 | 300 - 100,000 | 8,890 | 8,080 |
| Manganese | 342 | | | 100% | 70.0 | 2,000 | 70 - 2,000 | 414 | 272 |
| Mercury | 309 | | 3 | 99% | 0.010 | 4.60 | 0.01 - 4.6 | 0.077 | 0.276 |
| Molybdenum | 340 | | 328 | 4% | 3.00 | 7.00 | 3 - 7 | 1.59 | 0.522 |
| Neodymium | 256 | | 198 | 23% | 70.0 | 300 | 70 - 300 | 47.1 | 31.7 |
| Nickel | 342 | | 12 | 96% | 5.00 | 700 | 5 - 700 | 18.8 | 39.8 |
| Niobium | 335 | | 123 | 63% | 10.0 | 100 | 10 - 100 | 11.4 | 8.68 |
| Phosphorus | 249 | | | 100% | 40.0 | 4,497 | 40 - 4,497 | 399 | 397 |
| Potassium | 341 | | | 100% | 1,900 | 63,000 | 1,900 - 63,000 | 18,900 | 6,980 |
| Rubidium | 85 | | | 100% | 35.0 | 140 | 35 - 140 | 75.8 | 25.0 |
| Scandium | 342 | | 51 | 85% | 5.00 | 30.0 | 5 - 30 | 8.64 | 4.69 |
| Selenium | 309 | | 60 | 81% | 0.102 | 4.32 | 0.1023 - 4.3183 | 0.349 | 0.415 |
| Silicon | 85 | | | 100% | 149,340 | 413,260 | 149,340 - 413,260 | 302,000 | 61,500 |
| Sodium | 335 | | | 100% | 500 | 70,000 | 500 - 70,000 | 10,400 | 6,260 |
| Strontium | 342 | | | 100% | 10.0 | 2,000 | 10 - 2,000 | 243 | 212 |
| Sulfur | 85 | | 71 | 16% | 816 | 47,760 | 816 - 47,760 | 1,250 | 5,300 |
| Thallium | 76 | | | 100% | 2.45 | 20.8 | 2.45 - 20.79 | 9.71 | 3.54 |
| Tin | 85 | | 3 | 96% | 0.117 | 5.00 | 0.117 - 5.001 | 1.15 | 0.772 |
| Titanium | 342 | | | 100% | 500 | 7,000 | 500 - 7,000 | 2,290 | 1,350 |
| Uranium | 85 | | | 100% | 1.11 | 5.98 | 1.11 - 5.98 | 2.87 | 0.883 |
| Vanadium | 342 | | | 100% | 7.00 | 300 | 7 - 300 | 73.0 | 41.7 |
| Ytterbium | 330 | | 3 | 99% | 1.00 | 20.0 | 1 - 20 | 3.33 | 2.06 |
| Yttrium | 342 | | 7 | 98% | 10.0 | 150 | 10 - 150 | 26.9 | 18.1 |
| Zinc | 330 | | | 100% | 10.0 | 2,080 | 10 - 2,080 | 72.4 | 159 |
| Zirconium | 342 | | | 100% | 30.0 | 1,500 | 30 - 1,500 | 220 | 157 |

^a The western U.S. background data set (Shacklette and Boemgen 1984) is composed of background values from Colorado, as well as all states bordering Colorado (Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming). See Section 4.0.

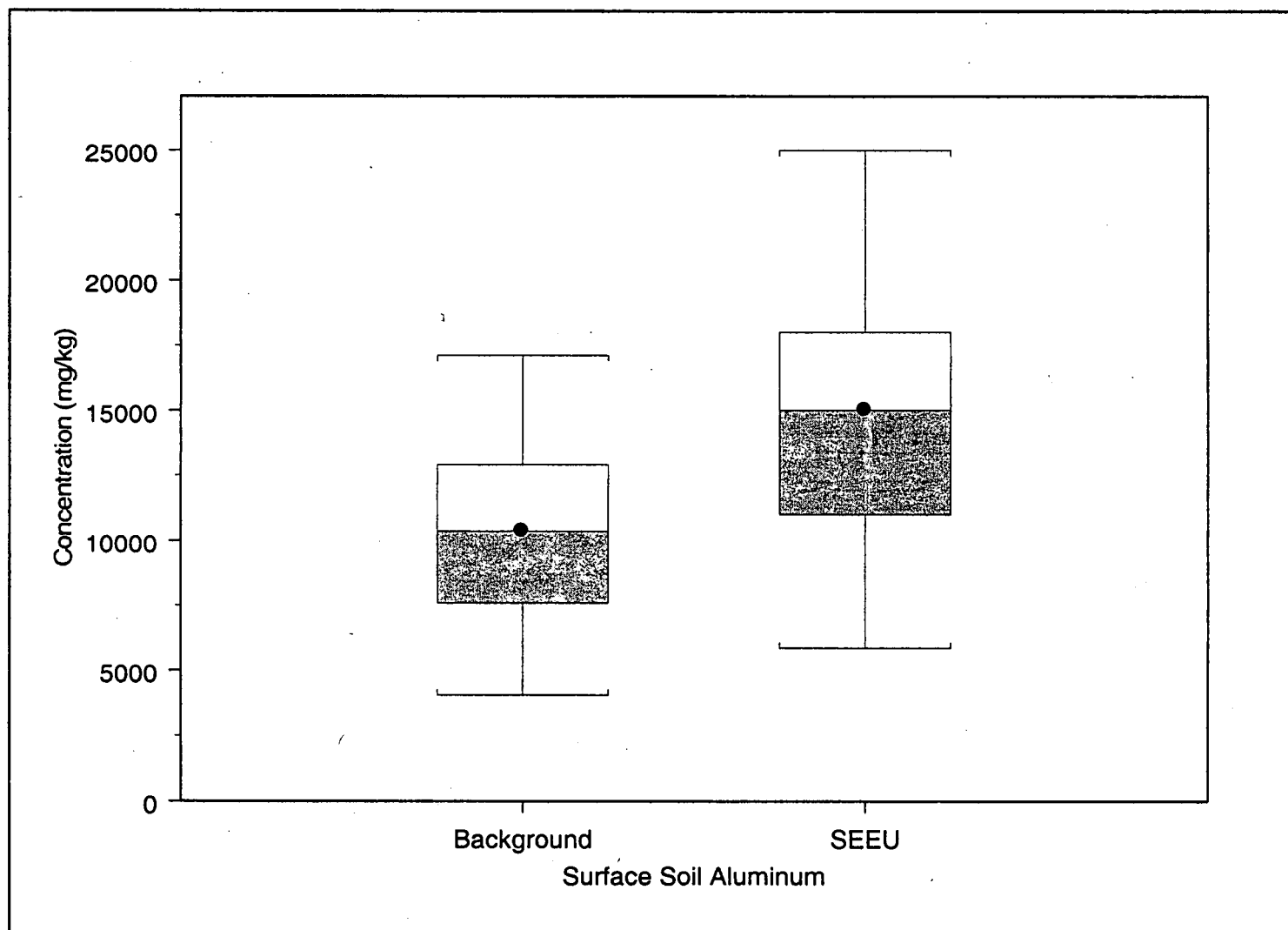
^b The element was measured at a concentration greater than the upper determination limit for the technique.

^c Average and standard deviation values were calculated using one-half the reported value for nondetects.

FIGURES

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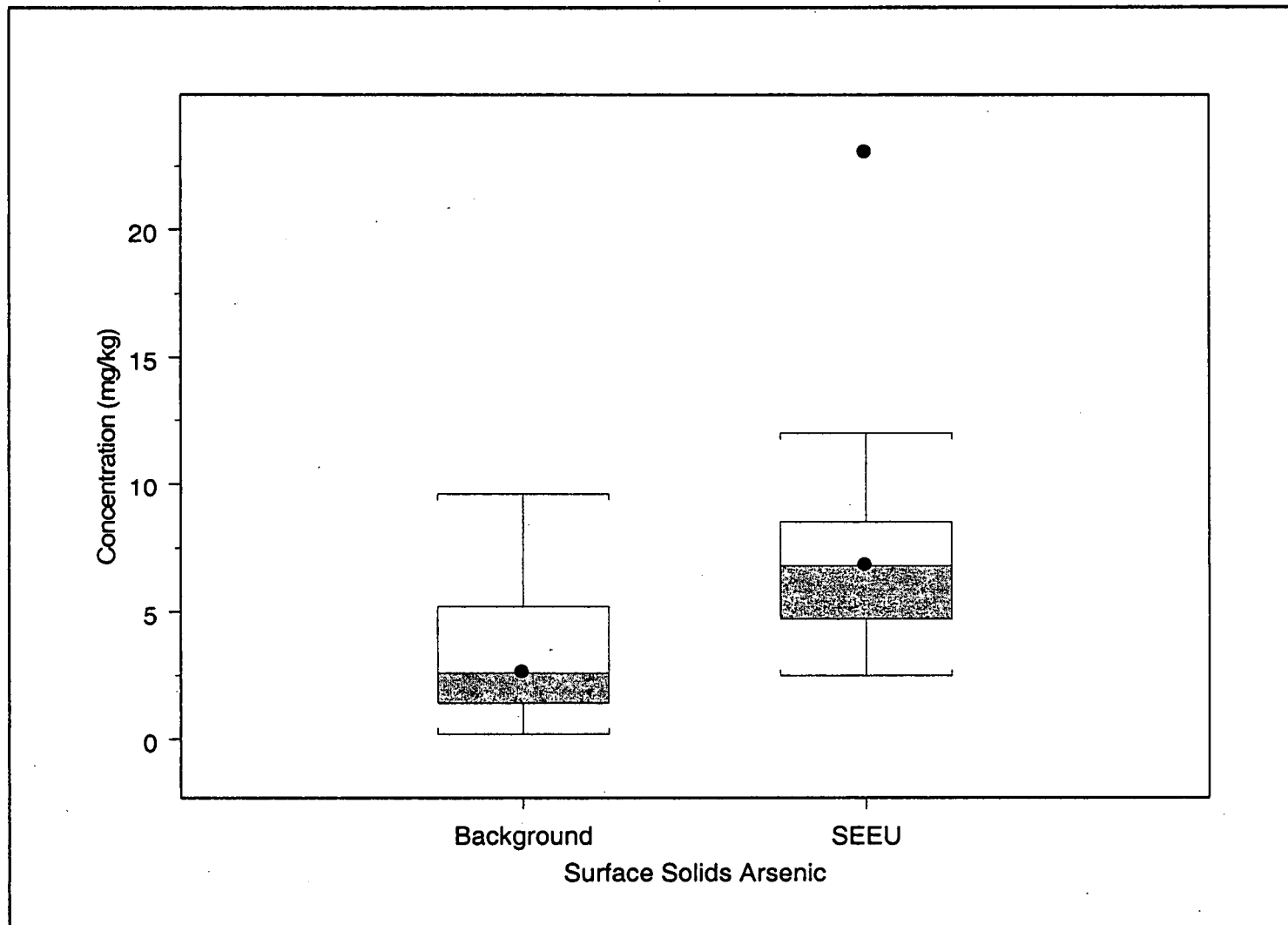
Figure A3.2.1
SEEU Surface Soil Box Plots for Aluminum



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.2

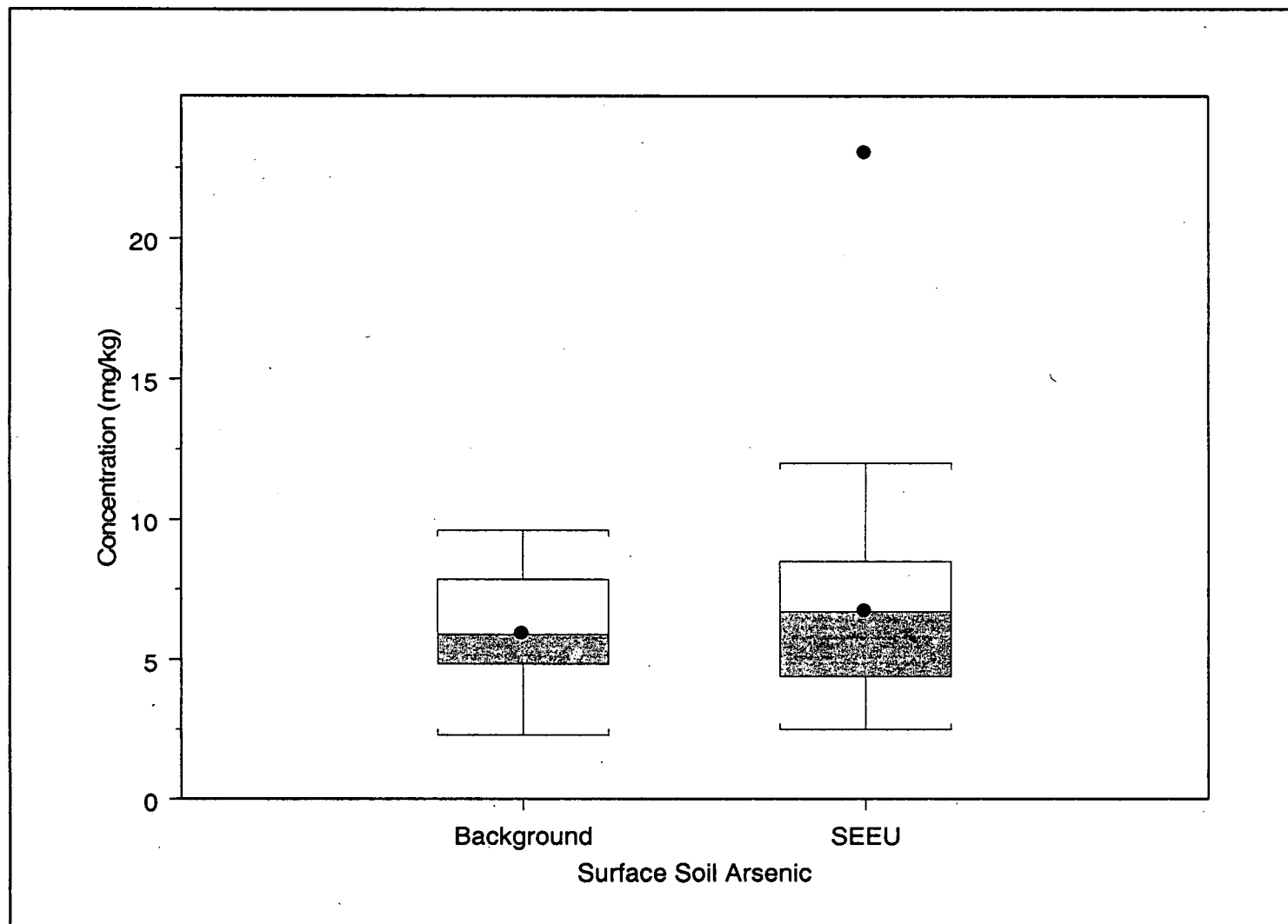
SEEU Surface Soil/Surface Sediment Box Plots for Arsenic



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

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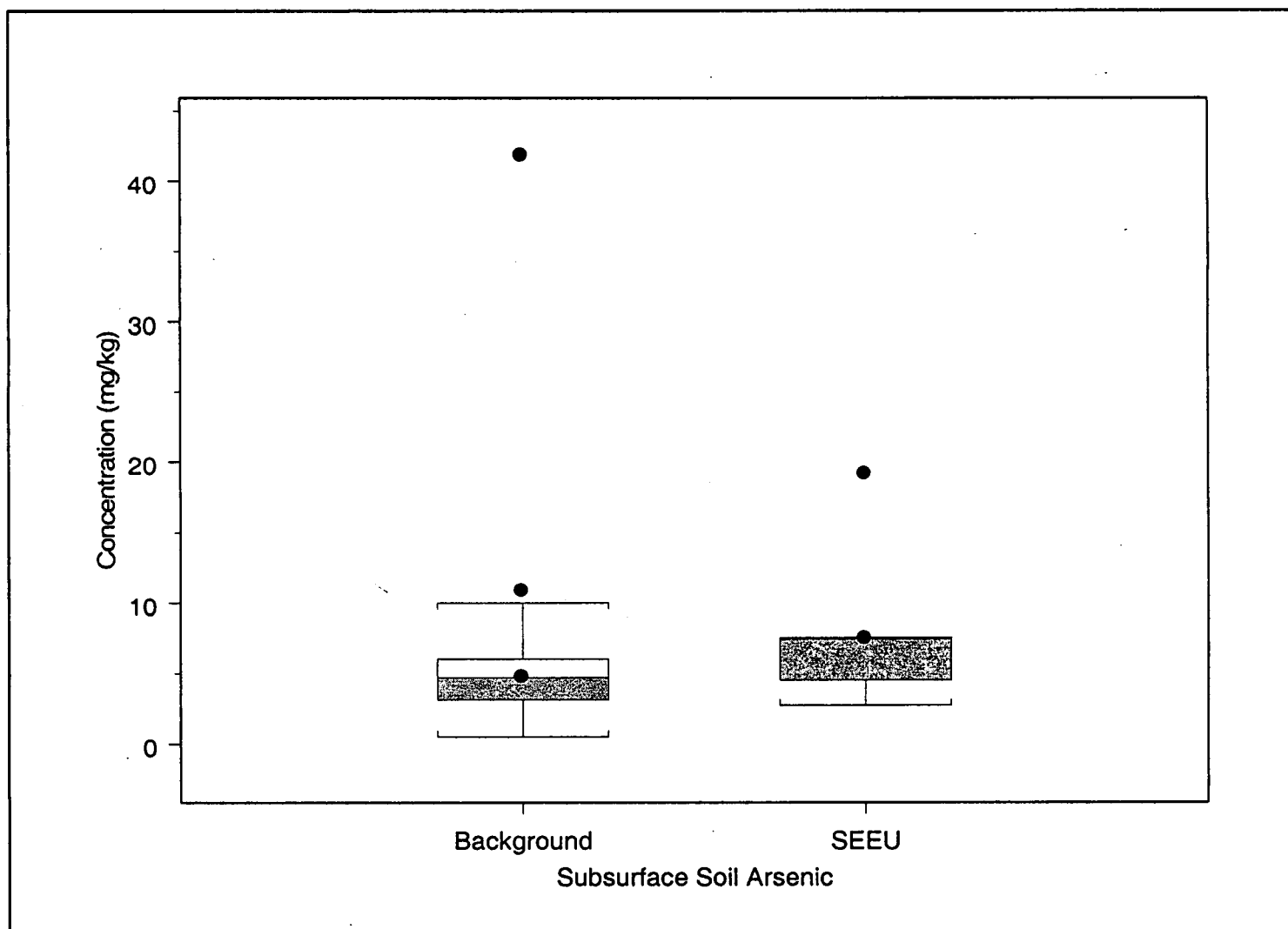
Figure A3.2.3
SEEU Surface Soil Box Plots for Arsenic



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

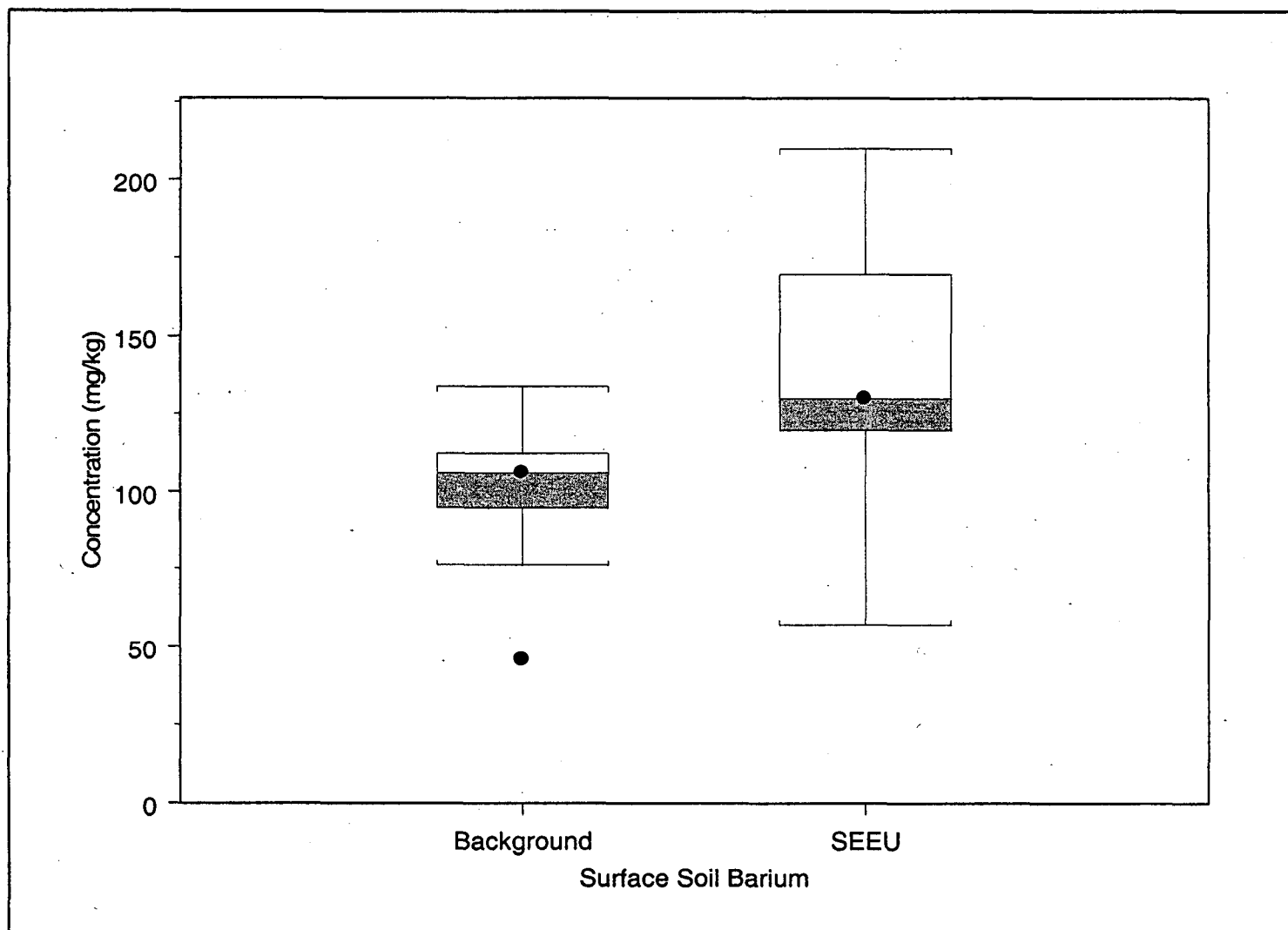
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Figure A5.2.4
SEEU Subsurface Soil Box Plots for Arsenic



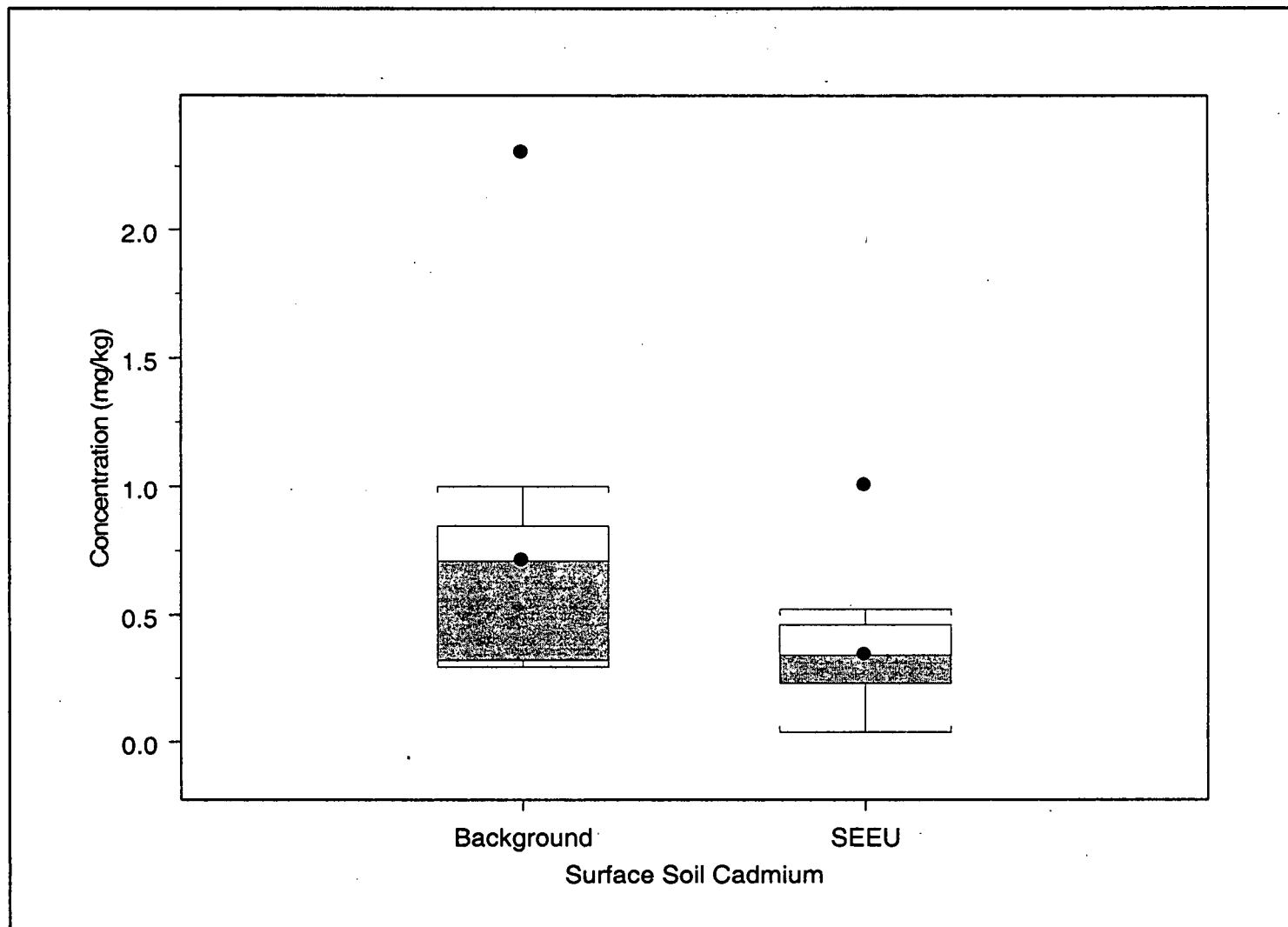
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

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Figure A3.2.5
SEEU Surface Soil Box Plots for Barium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

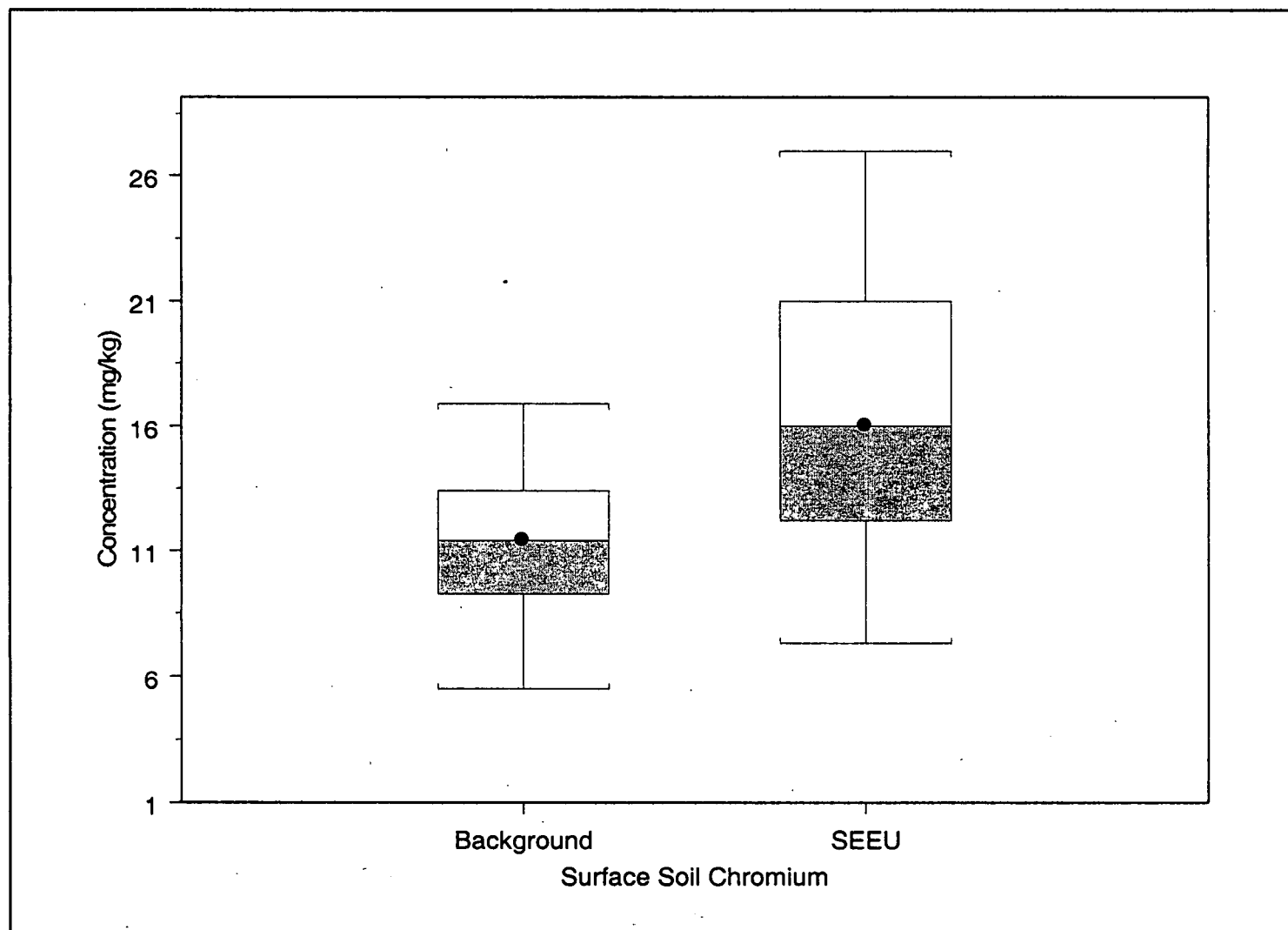
Figure AS.2.6
SEEU Surface Soil Box Plots for Cadmium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

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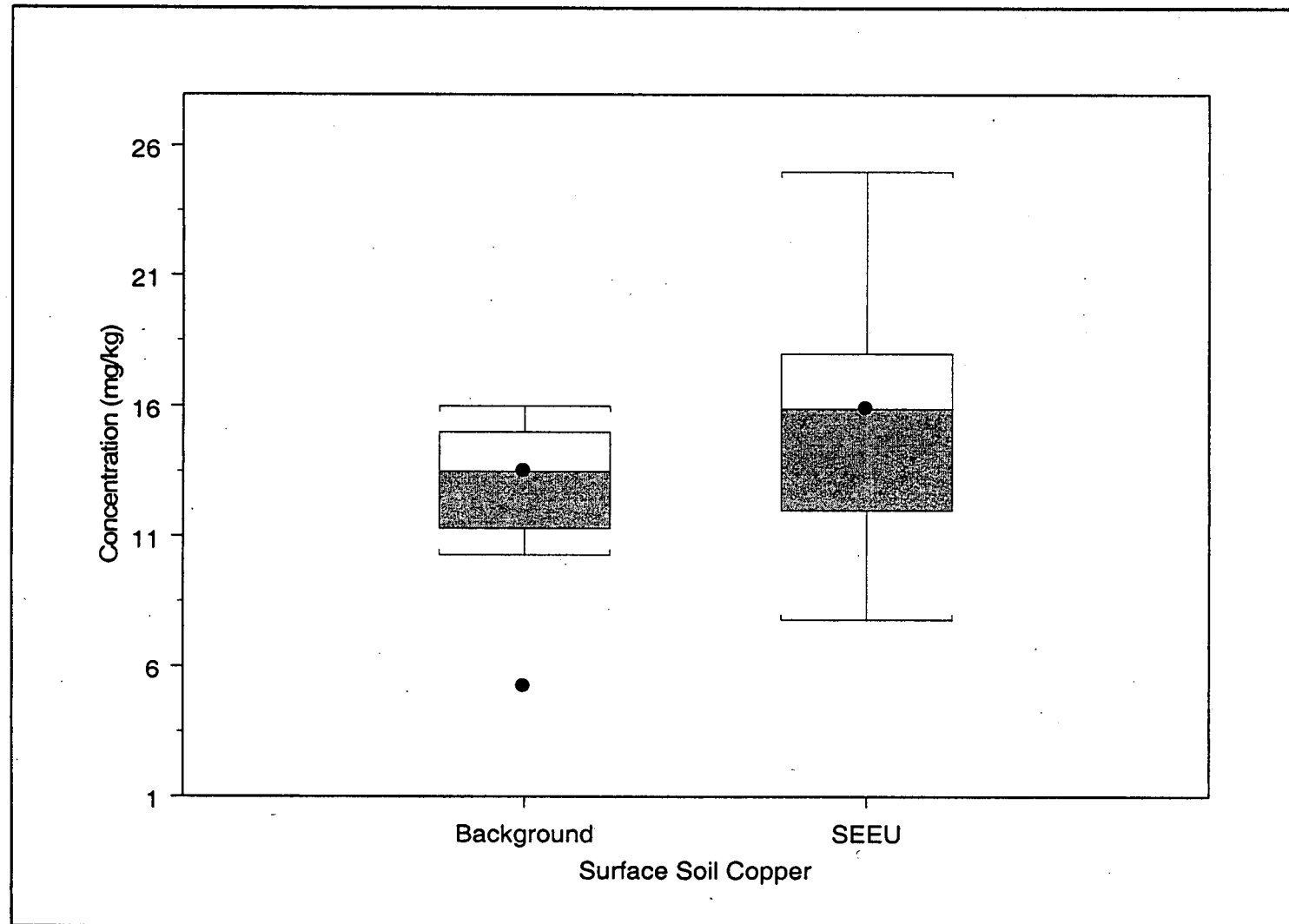
Figure A3.2.7
SEEU Surface Soil Box Plots for Chromium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

135

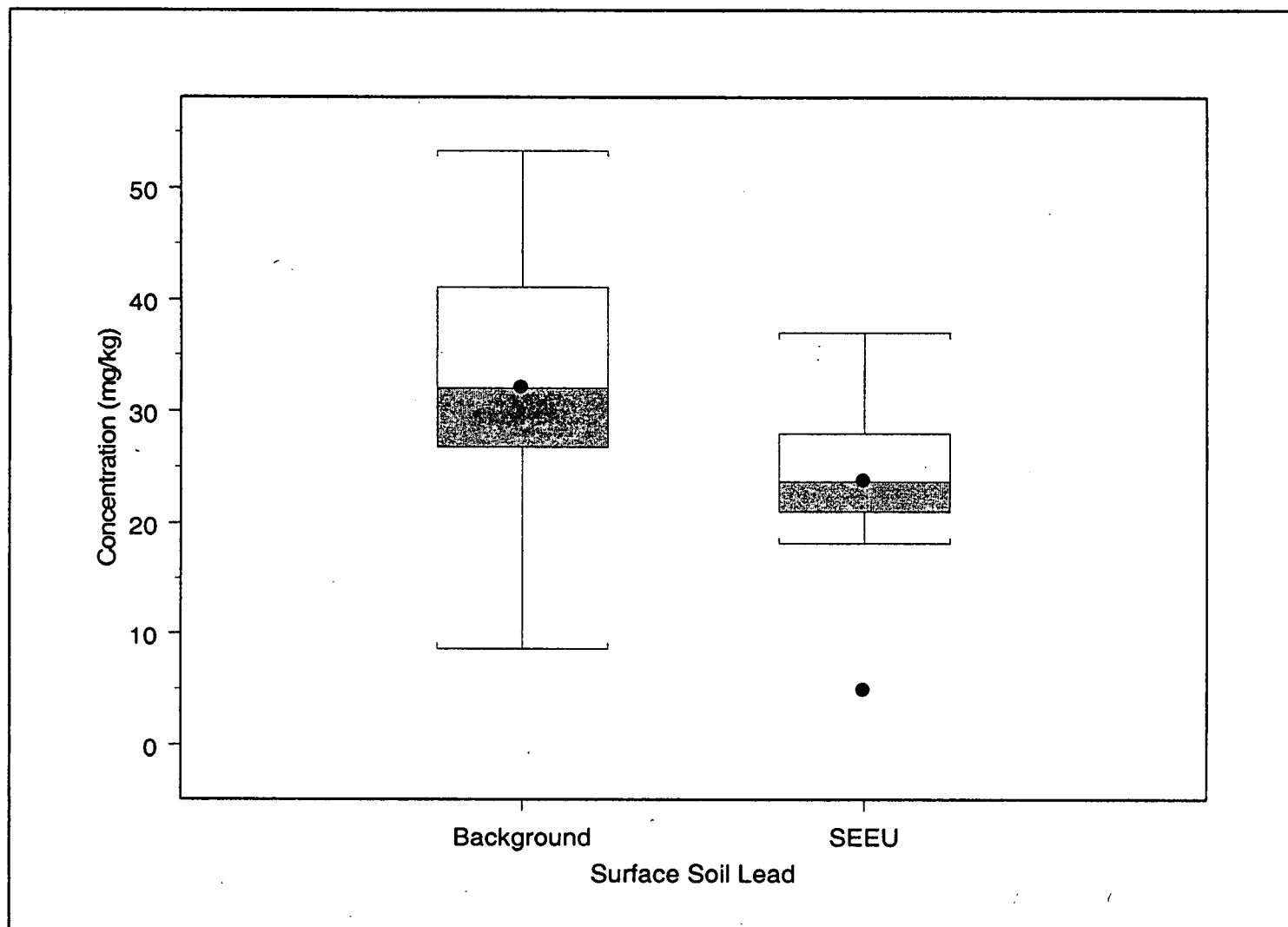
Figure A3.2.8
SEEU Surface Soil Box Plots for Copper



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

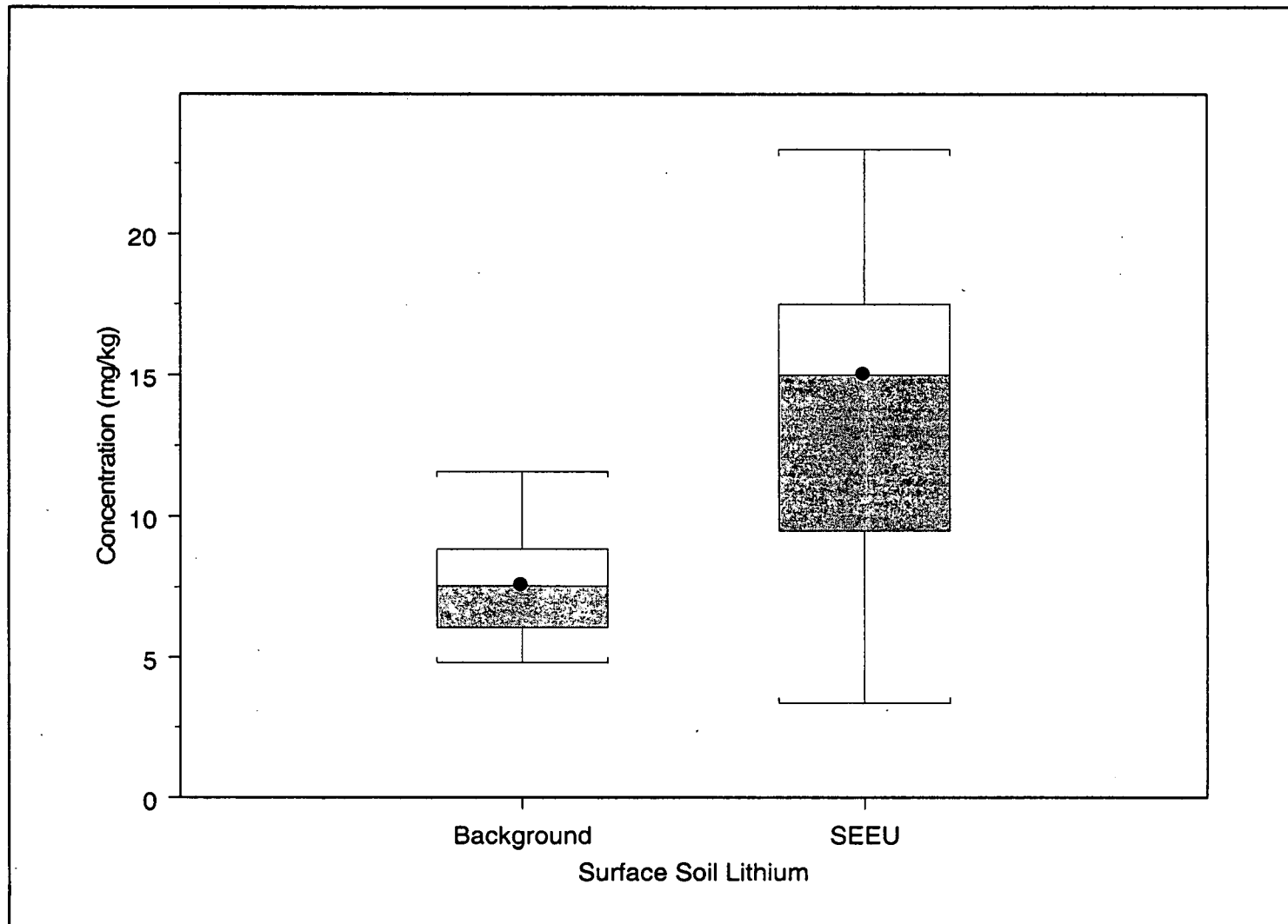
136

Figure A3.2.9
SEEU Surface Soil Box Plots for Lead



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

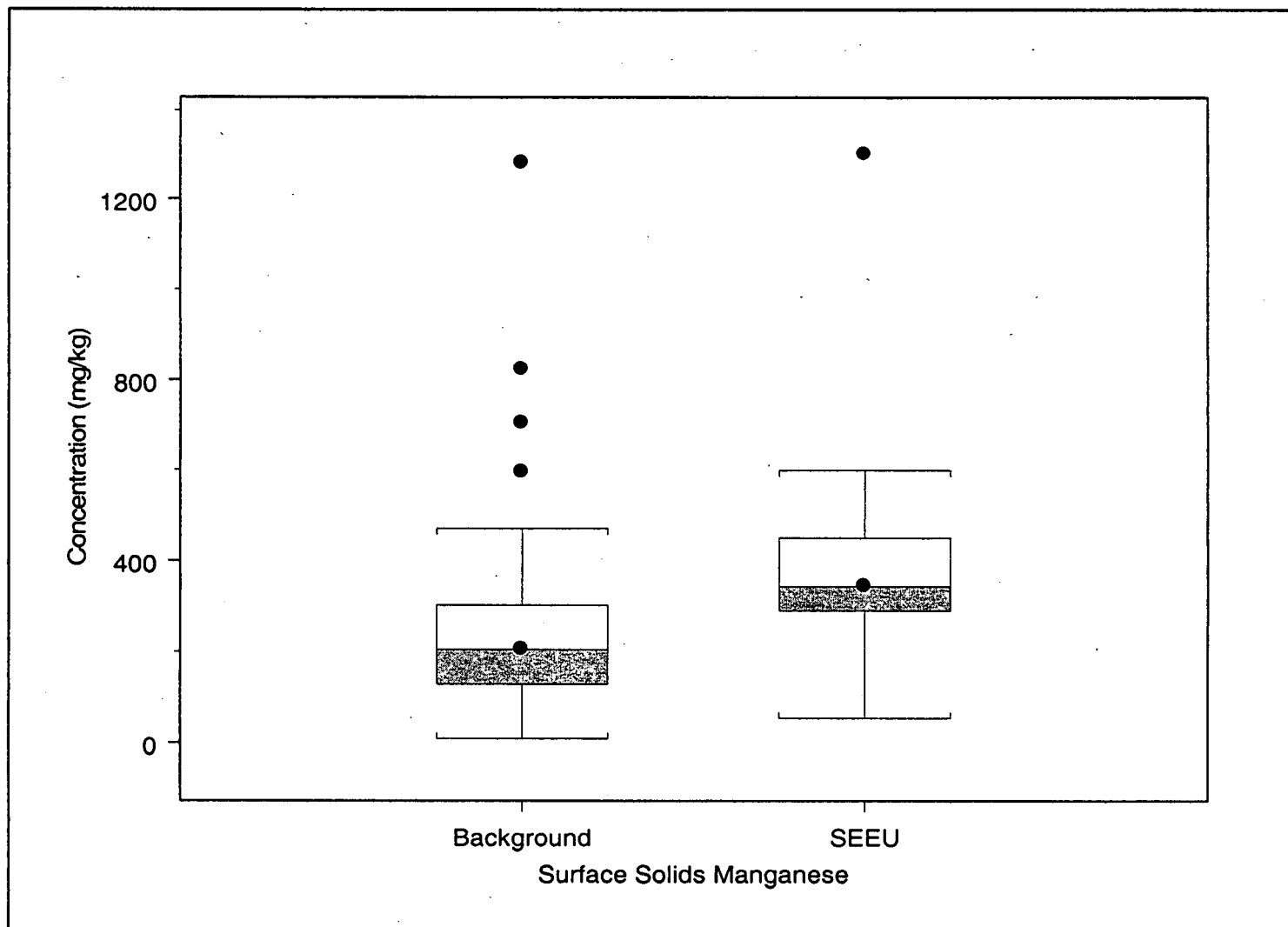
137
Figure A3.2.10
SEEU Surface Soil Box Plots for Lithium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.11

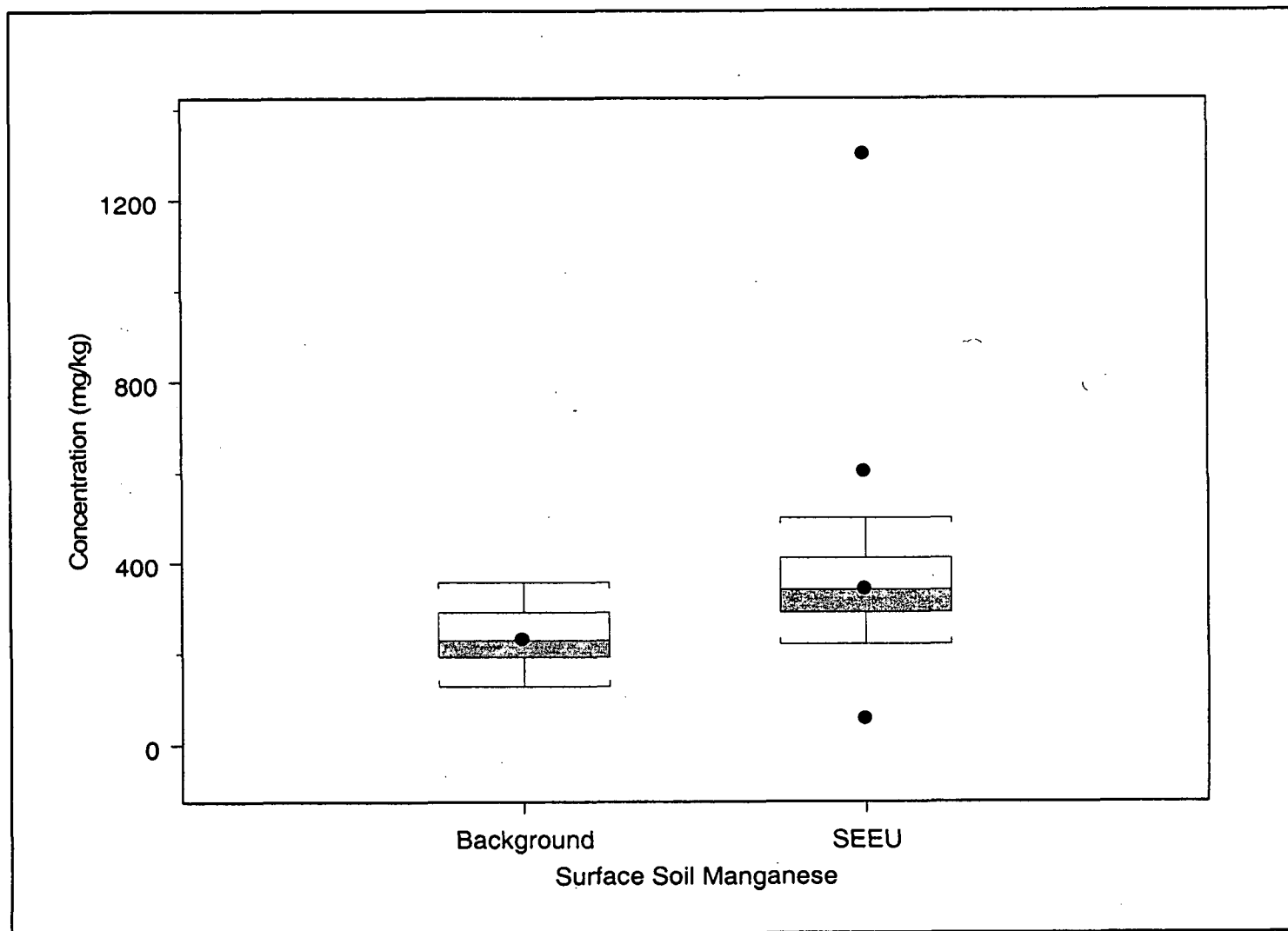
SEEU Surface Soil/Surface Sediment Box Plots for Manganese



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

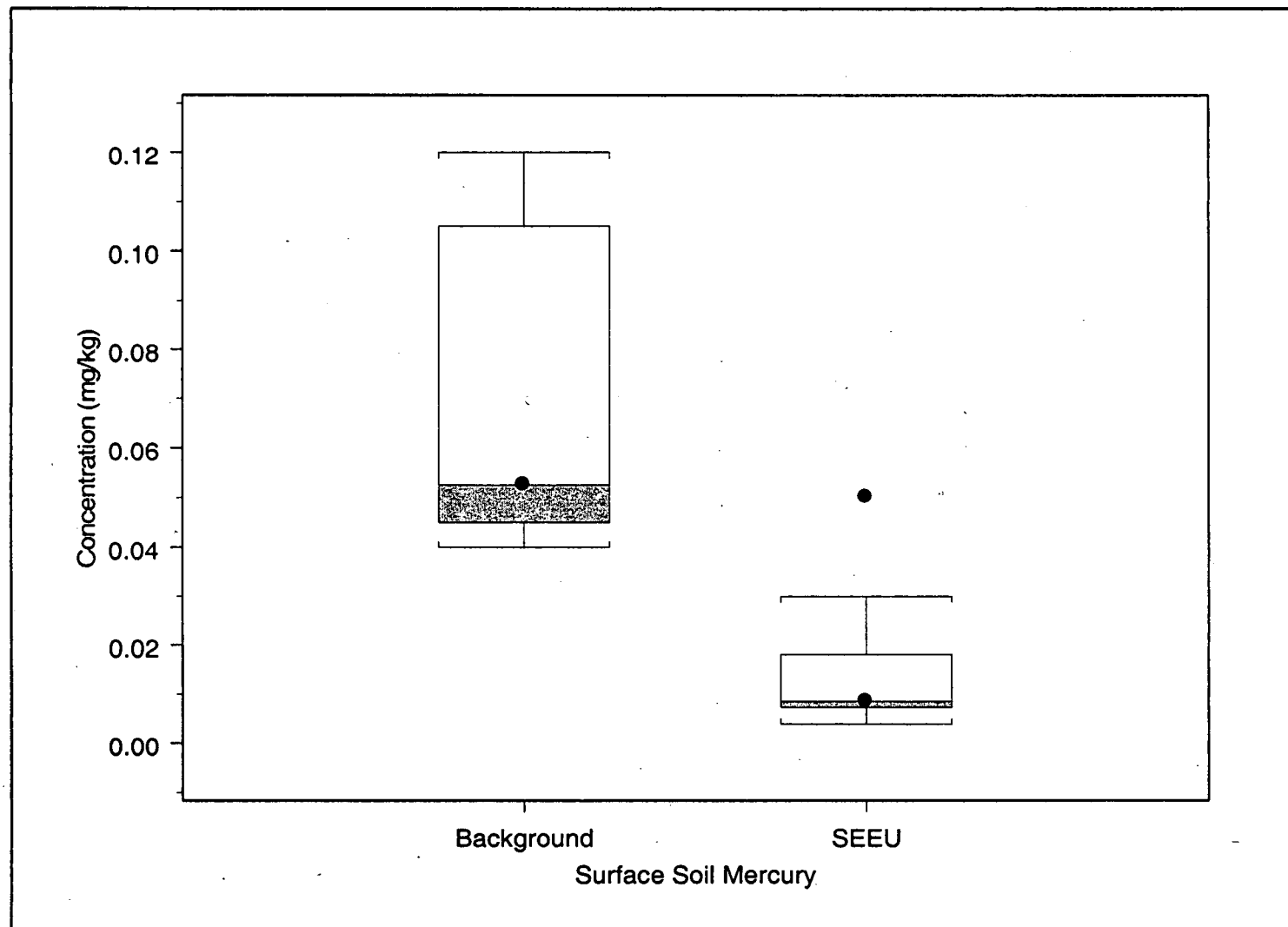
Figure A5.2.12

SEEU Surface Soil Box Plots for Manganese



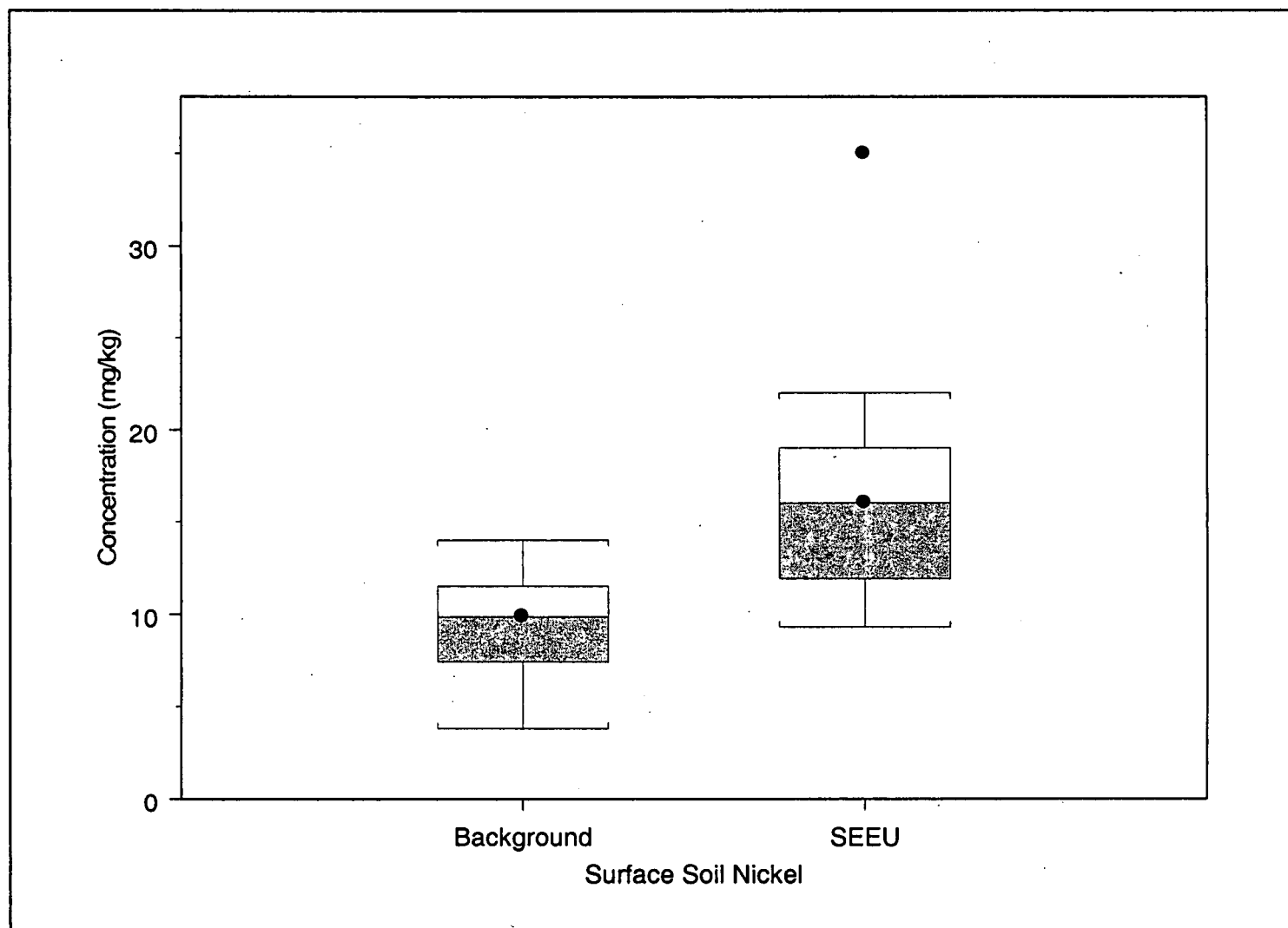
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure No. 2.13
SEEU Surface Soil Box Plots for Mercury



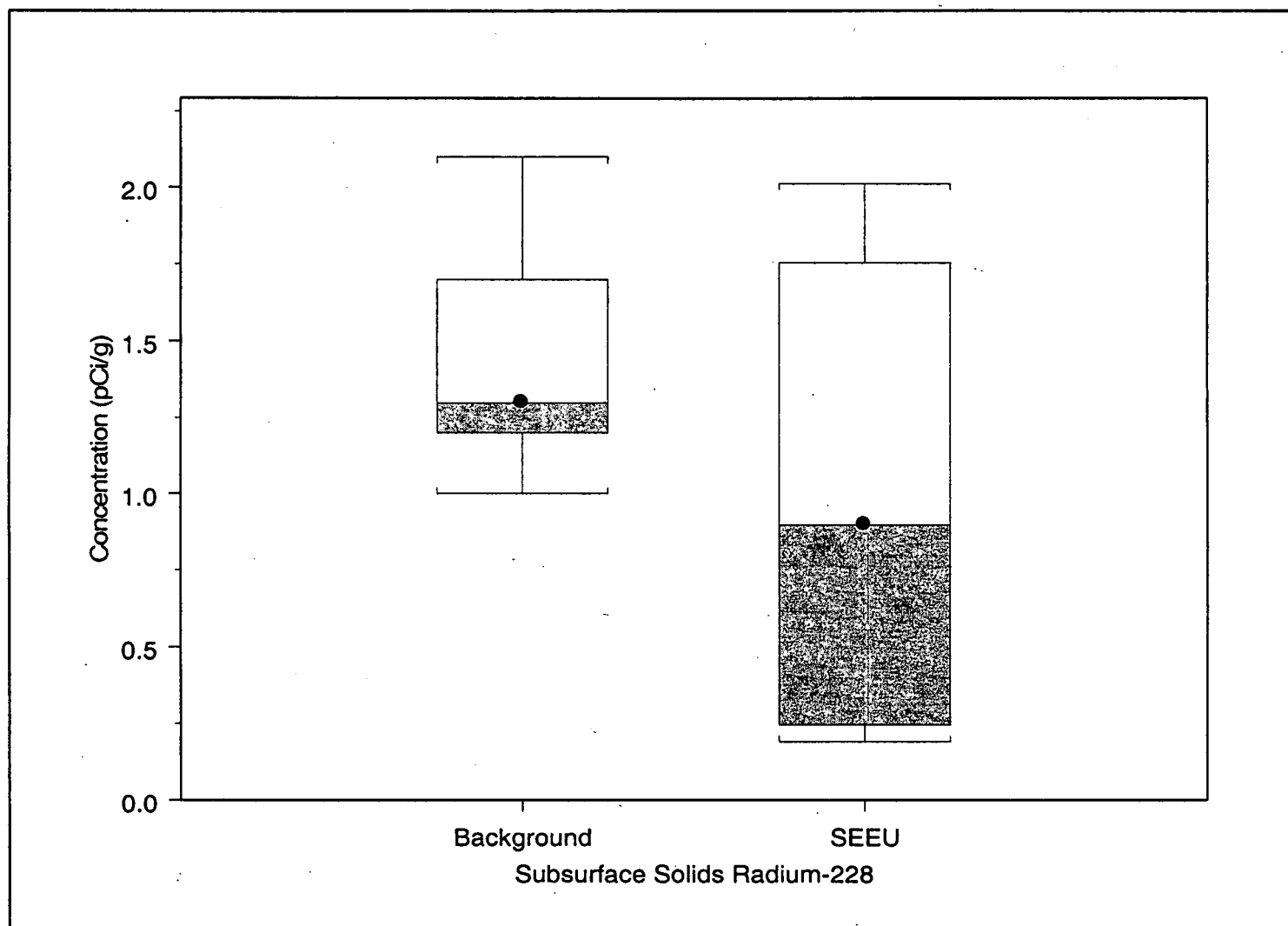
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.14
SEEU Surface Soil Box Plots for Nickel



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

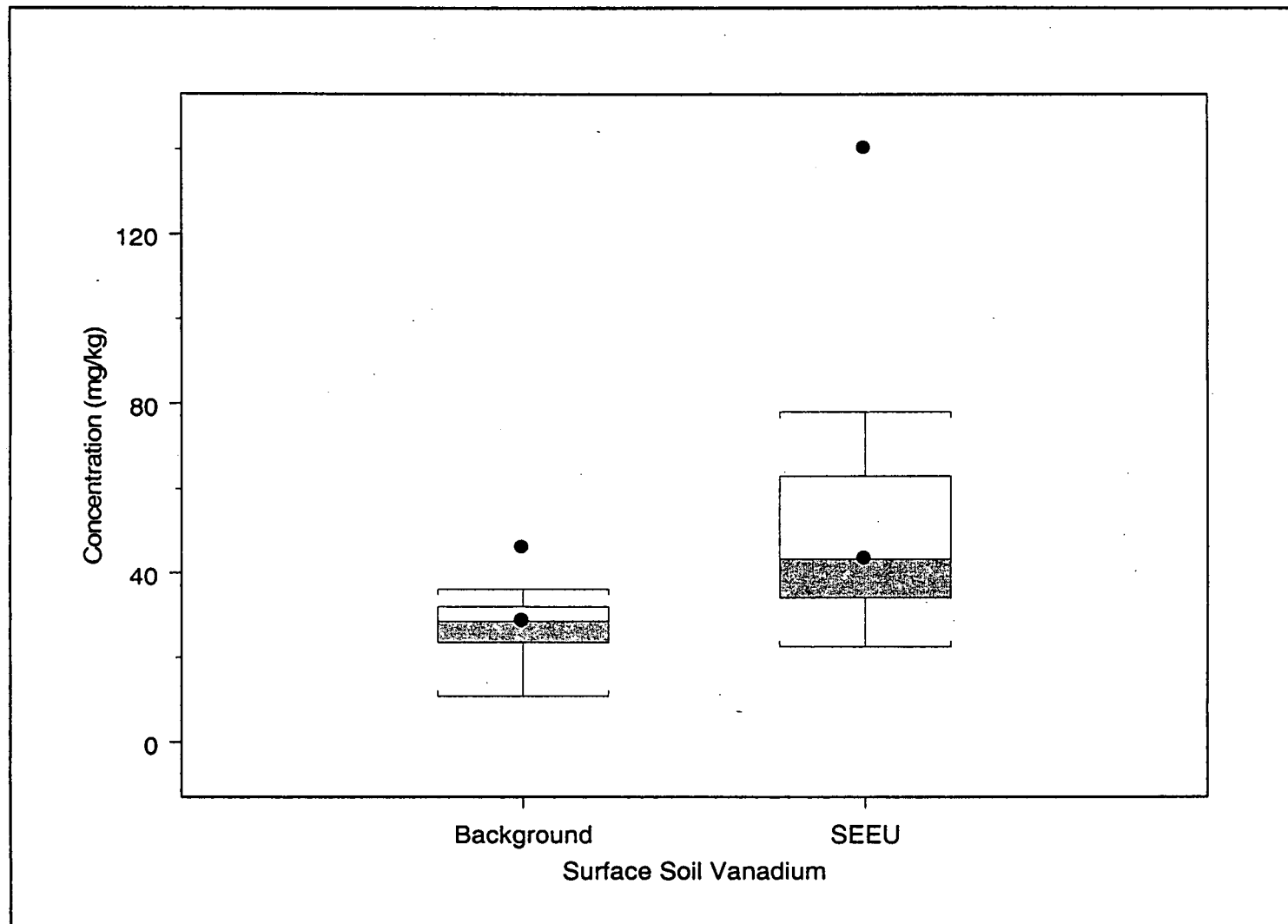
Figure AS.2.15
SEEU Surface Soil/Surface Sediment Box Plots for Radium-228



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

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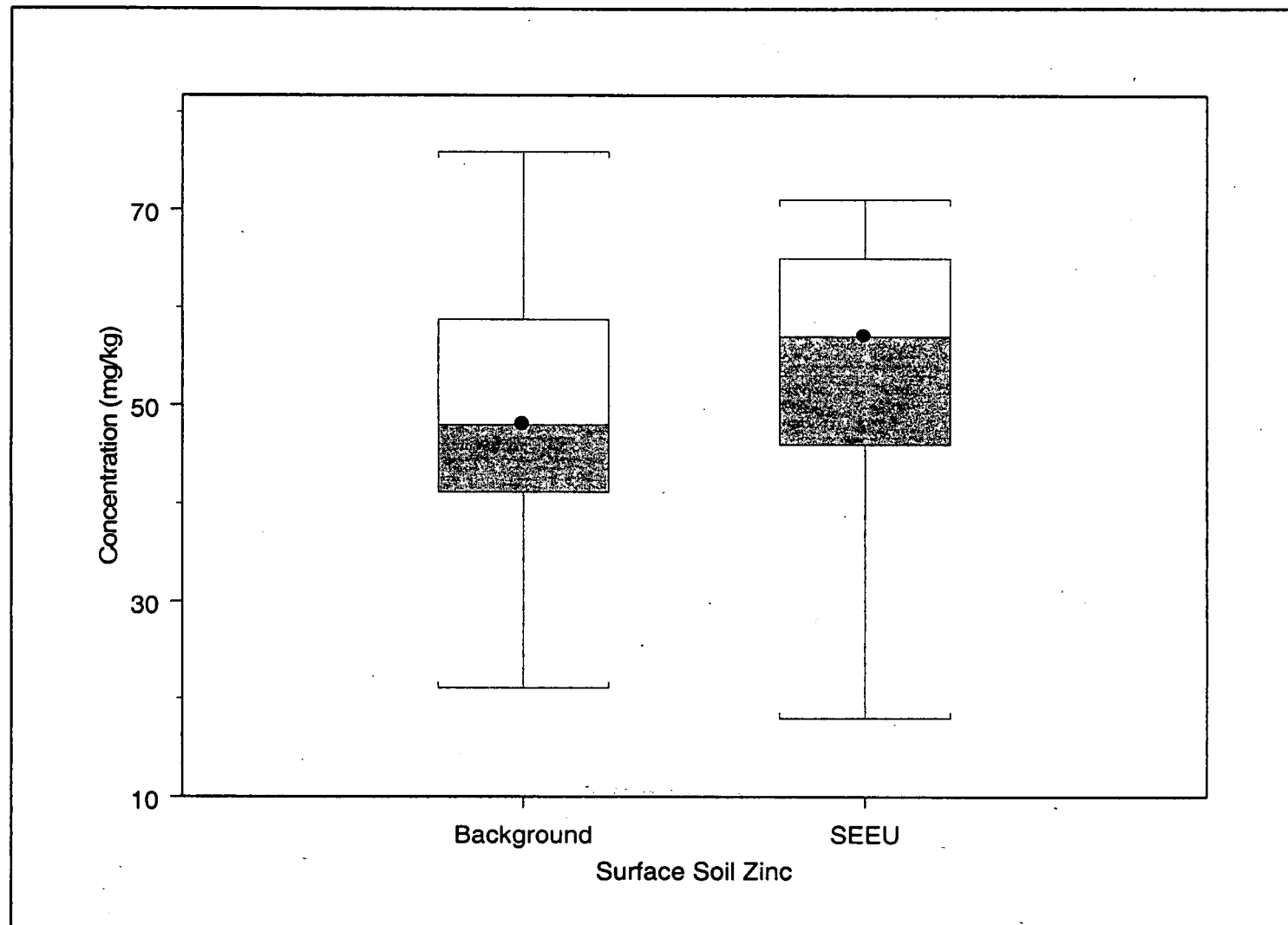
Figure A3.2.16
SEEU Surface Soil Box Plots for Vanadium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

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Figure A3.2.17
SEEU Surface Soil Box Plots for Zinc



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

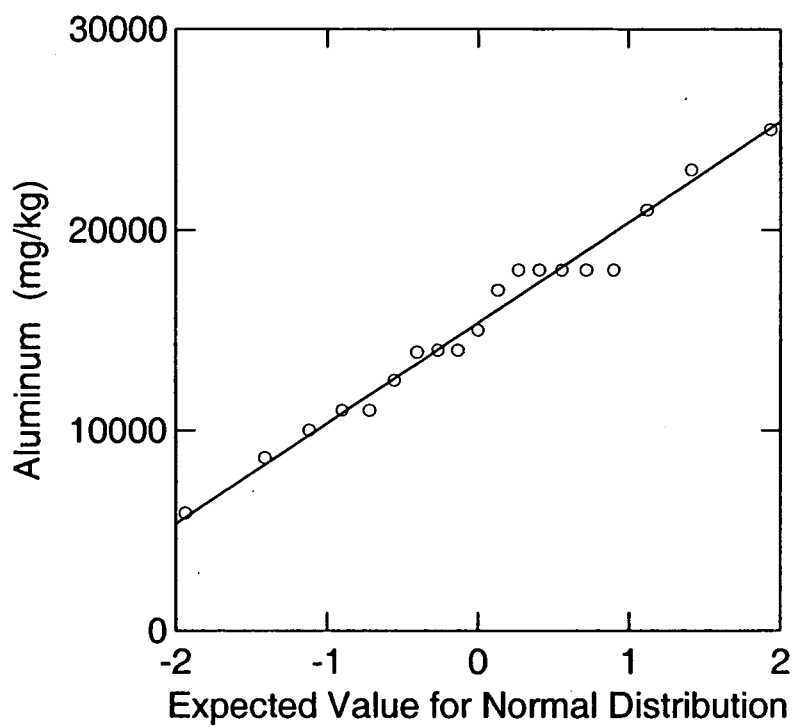


Figure A3.4.1. Probability Plot of Aluminum Concentrations (Natural Logarithm) in SEEU Surface Soil

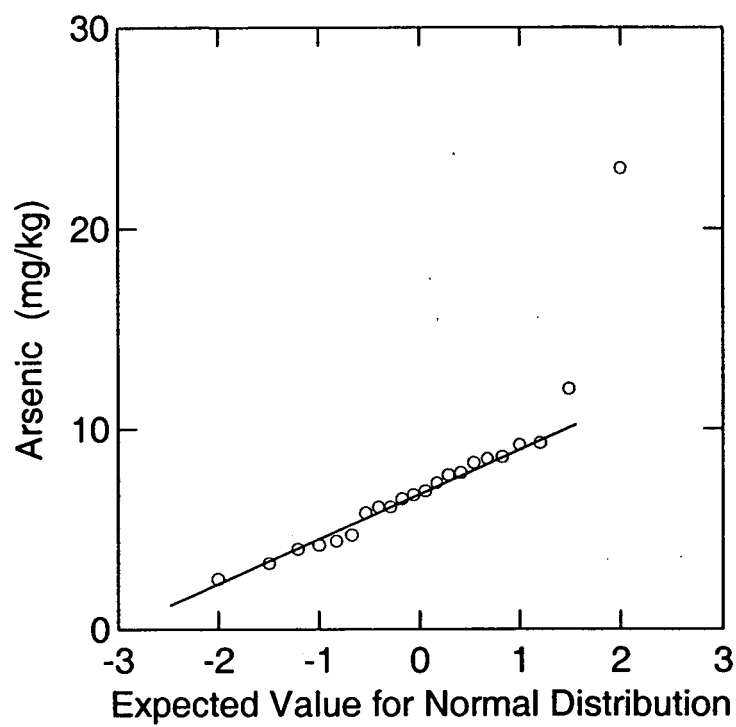


Figure A3.4.2. Probability Plot of Arsenic Concentrations (Natural Logarithm) in SEEU Surface Soil/Surface Sediment

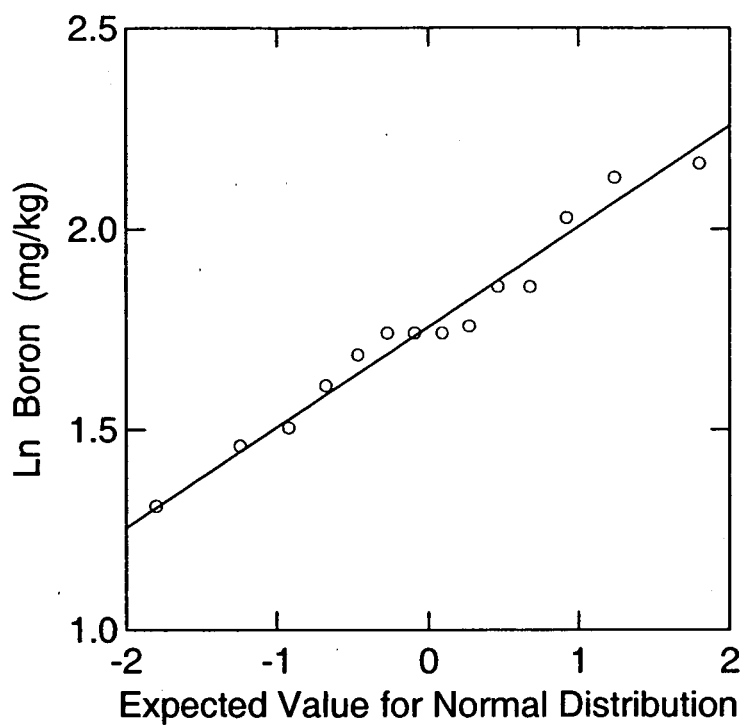


Figure A3.4.3. Probability Plot of Boron Concentrations (Natural Logarithm) in SEEU Surface Soil

Figure A3.4.4
Cesium-137
Activity in Sitewide
Surface Soil/Surface Sediment

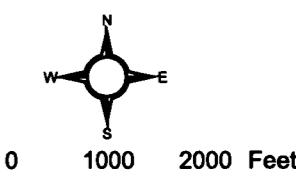
KEY

- Concentration > 3x Background MDC
- Concentration > Background MDC and ≤ 3x Background MDC
- Concentration > WRW PRG and ≤ Background MDC
- Concentration ≤ WRW PRG
- Nondetect (ND)

WRW PRG = 0.221 pCi/g
 Background MDC = 1.80 pCi/g
 3 x Background MDC = 5.4 pCi/g

Standard Map Features

- ▭ Southeast Buffer Zone Area EU
- ▭ Exposure Unit boundaries
- ▭ Former building where analyte was used or generated as waste
- ▭ Historical IHSS/PAC
- ▭ Pond
- Ephemeral stream
- - - Intermittent stream
- Perennial stream
- - - Site boundary

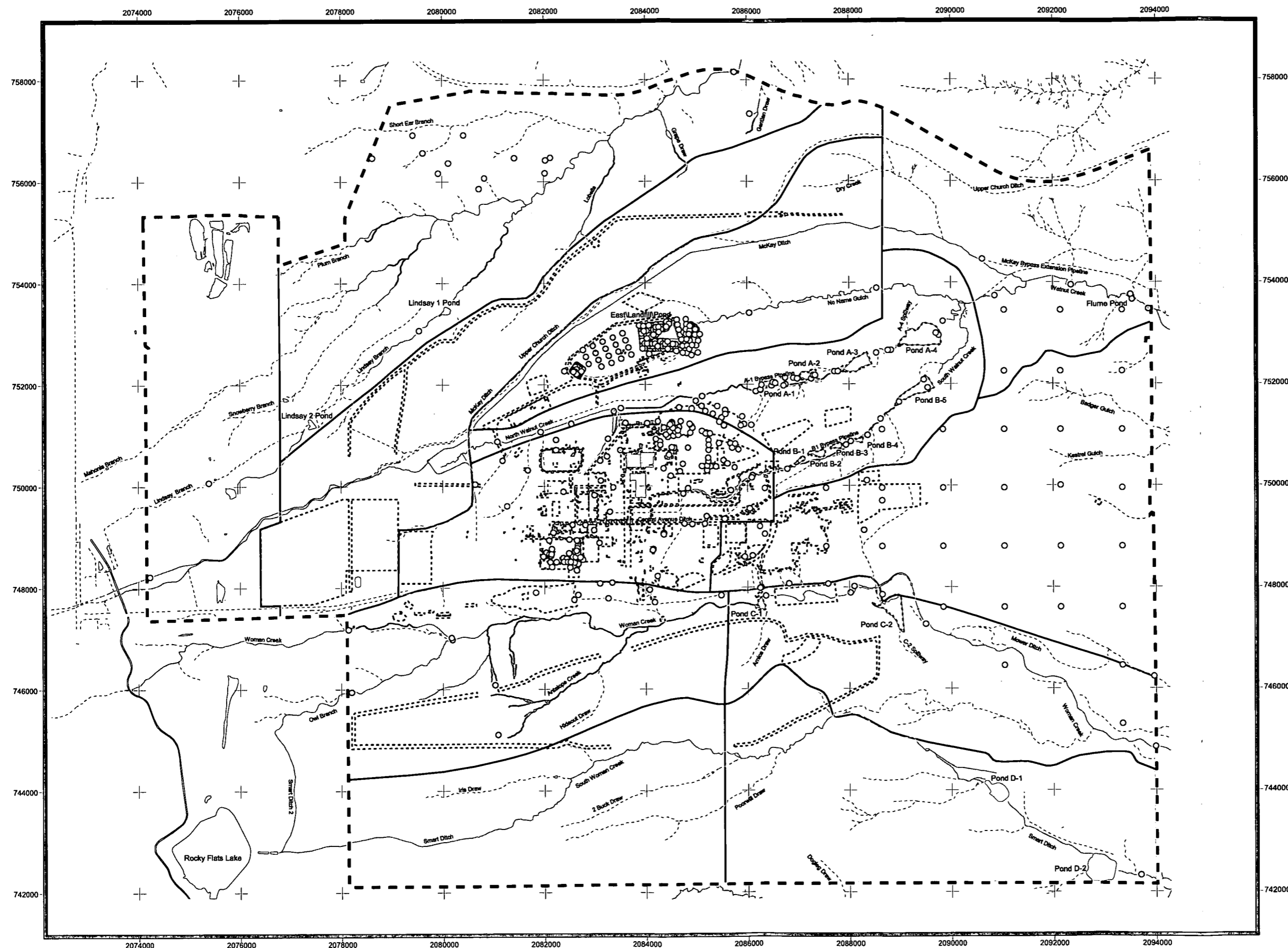


Scale 1:24,000
 State Plane Coordinate Projection
 Colorado Central Zone
 Datum: NAD 27

U.S. Department of Energy
 Rocky Flats Environmental
 Technology Site



File: W:\Projects\FY2005\CRA\ProfessionalJudgment\FINAL-profJudgment.apr



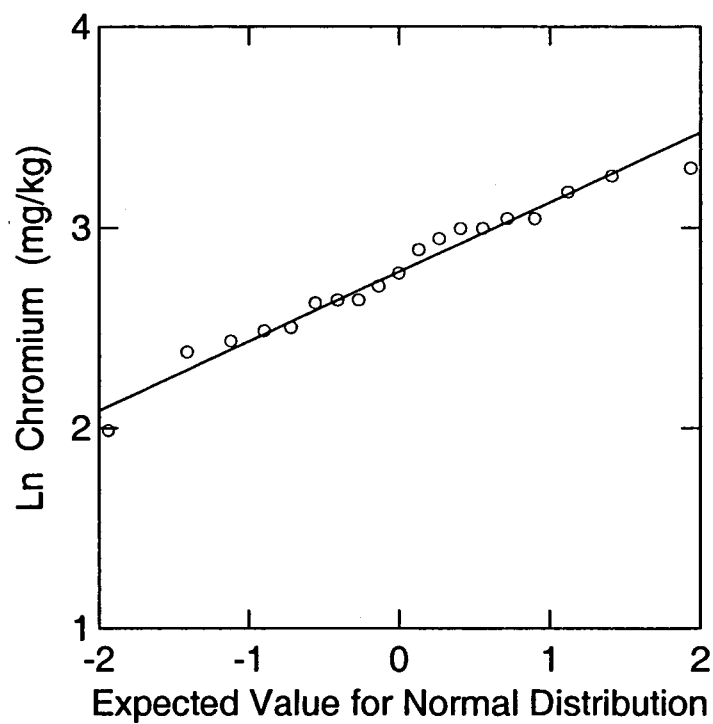


Figure A3.4.5. Probability Plot of Chromium Concentrations (Natural Logarithm) in SEEU Surface Soil

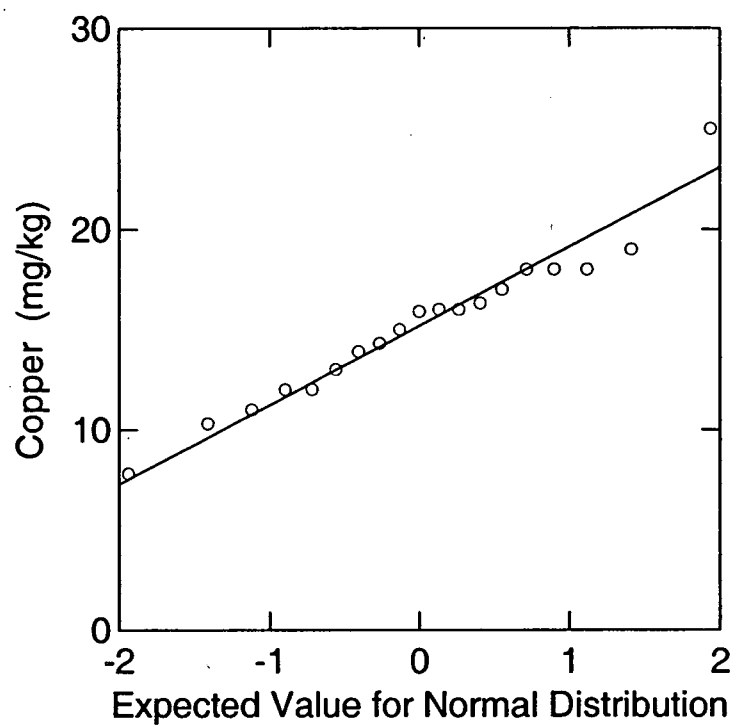


Figure A3.4.6. Probability Plot of Copper Concentrations (Natural Logarithm) in SEEU Surface Soil

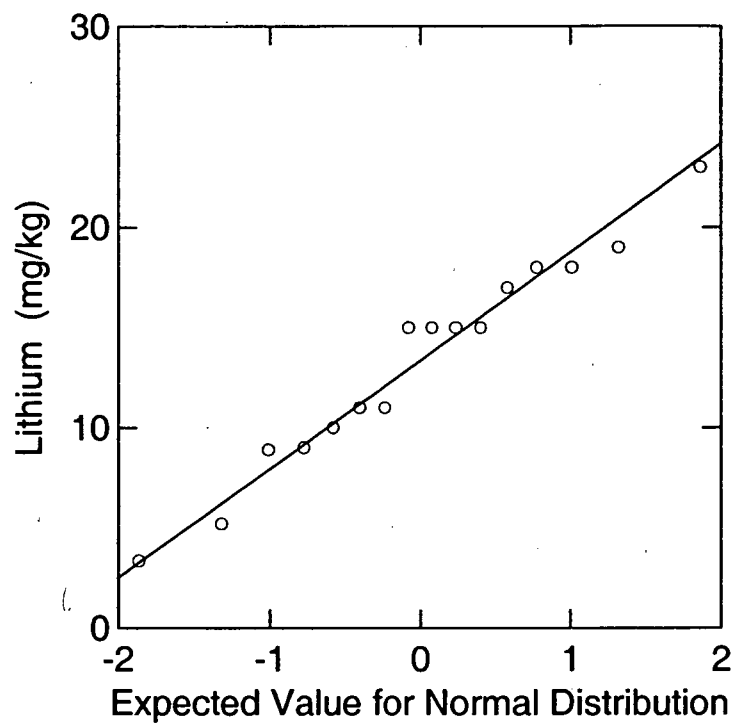


Figure A3.4.7. Probability Plot of Lithium Concentrations (Natural Logarithm) in SEEU Surface Soil

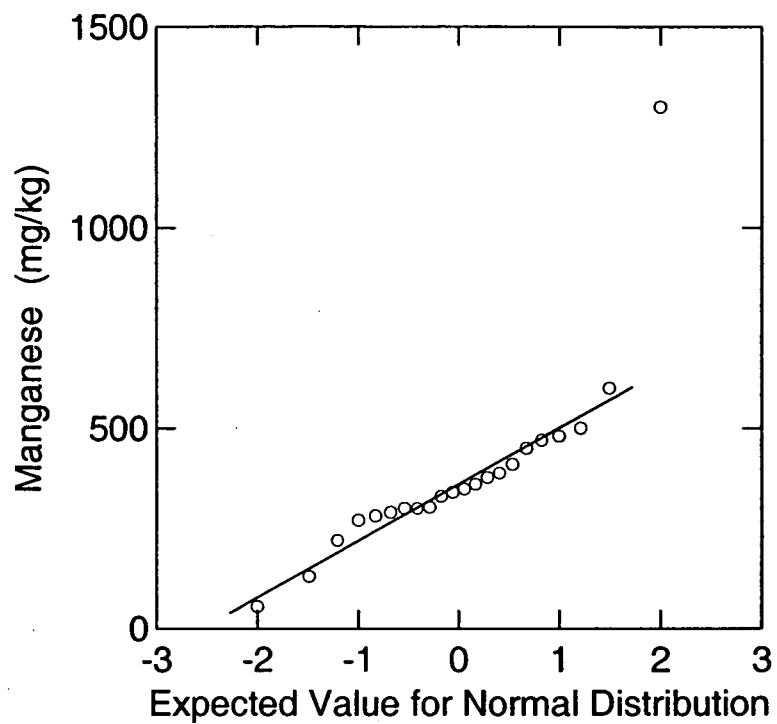


Figure A3.4.8. Probability Plot of Manganese Concentrations (Natural Logarithm) in SEEU Surface Soil/Surface Sediment

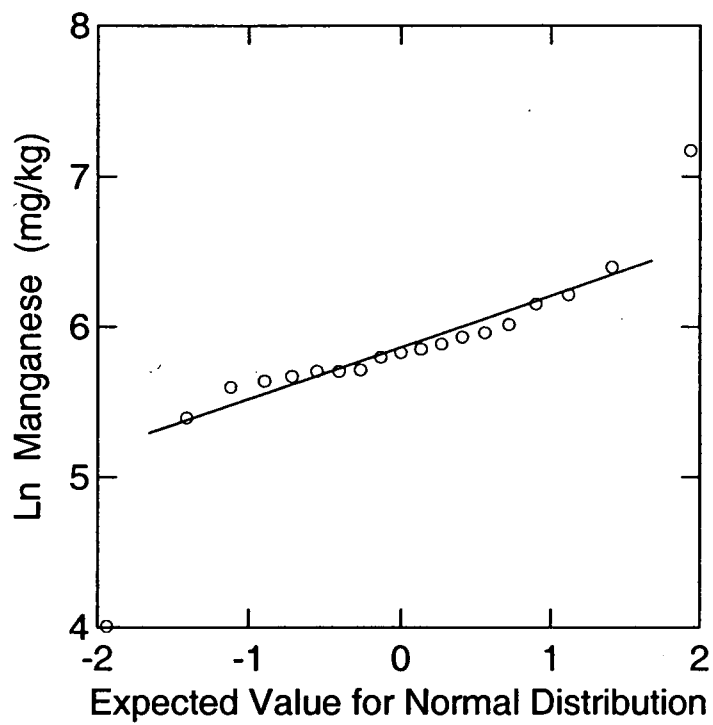


Figure A3.4.9. Probability Plot of Manganese Concentrations (Natural Logarithm) in SEEU Surface Soil

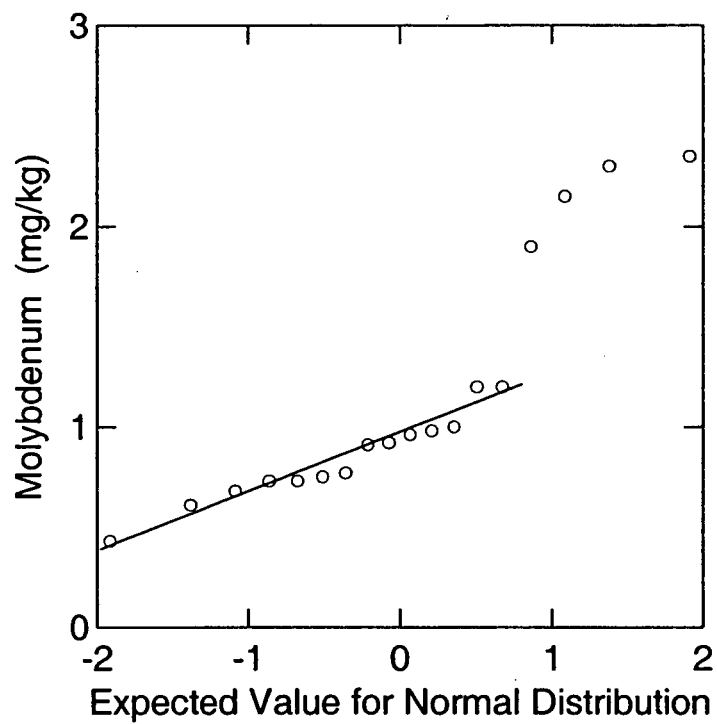


Figure A3.4.10. Probability Plot of Molybdenum Concentrations (Natural Logarithm) in SEEU Surface Soil

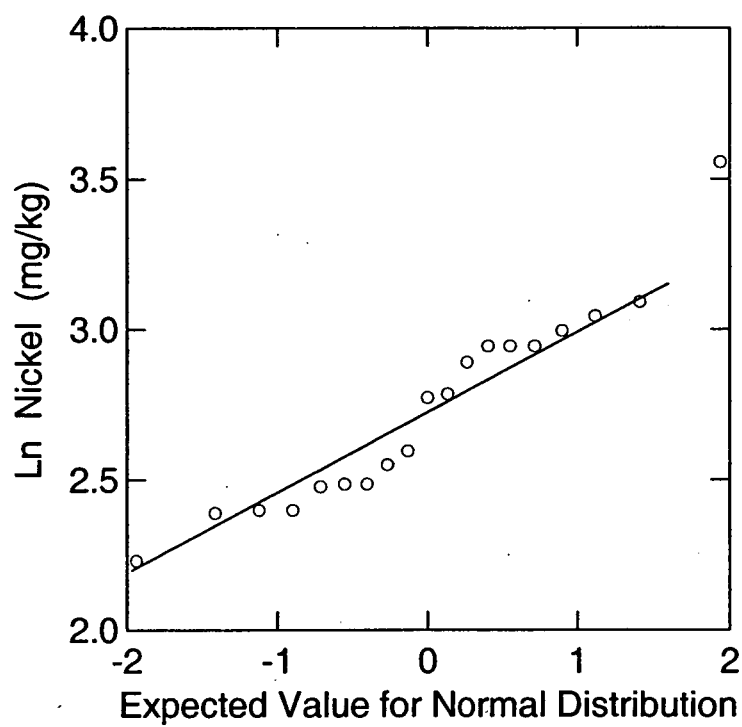
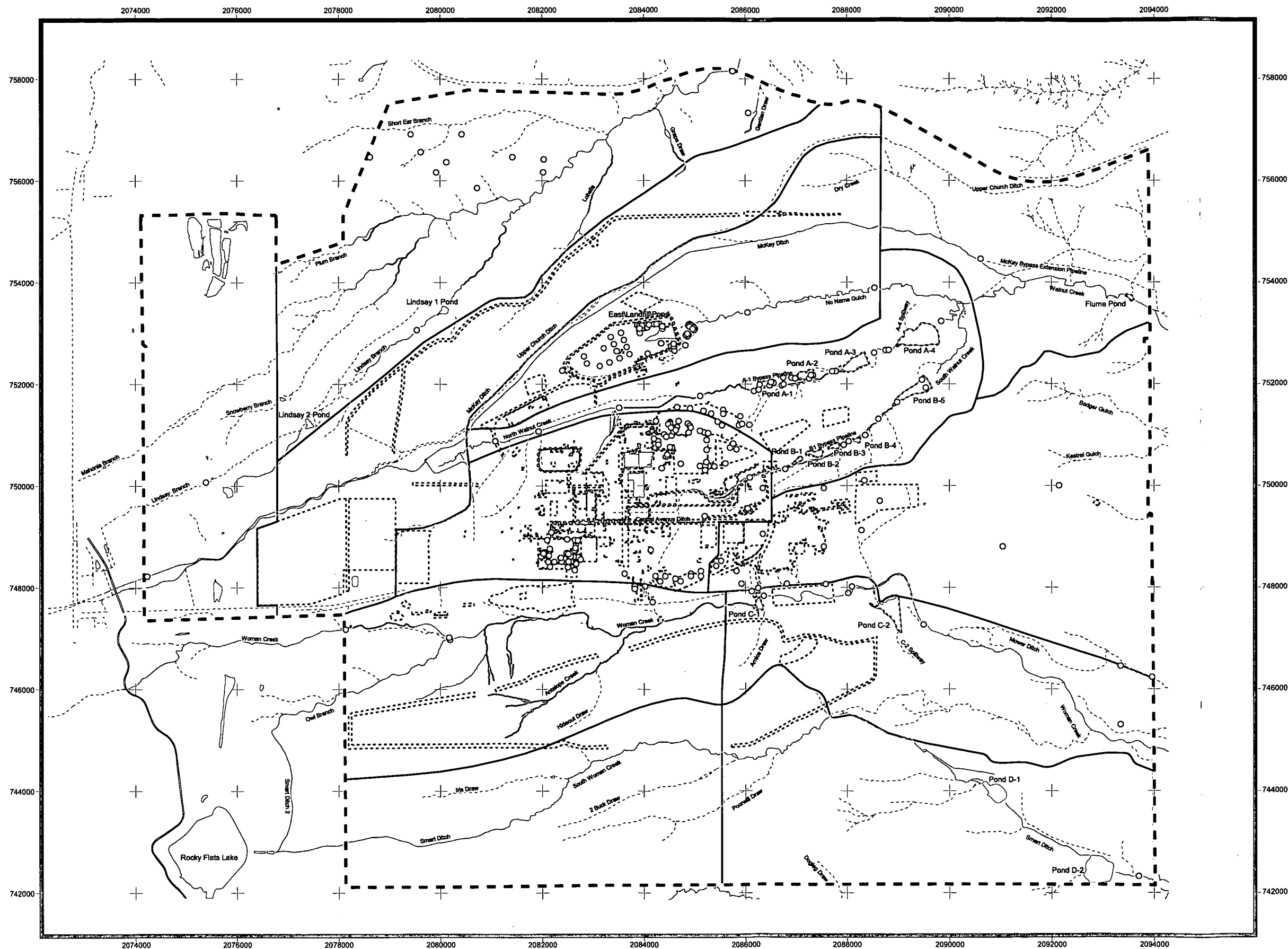


Figure A3.4.11. Probability Plot of Nickel Concentrations (Natural Logarithm) in SEEU Surface Soil

Figure A3.4.12
Radium-228
Activity in Sitewide
Surface Soil/Surface Sediment



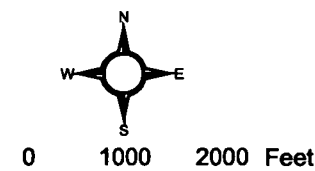
KEY

- Concentration > 3x Background MDC
- Concentration > Background MDC and ≤ 3x Background MDC
- Concentration > WRW PRG and ≤ Background MDC
- Concentration ≤ WRW PRG
- Nondetect (ND)

WRW PRG = 0.111 pCi/g
 Background MDC = 4.10 pCi/g
 3 x Background MDC = 12.3 pCi/g

Standard Map Features

- ▬ Southeast Buffer Zone Area EU
- ▬ Exposure Unit boundaries
- ▬ Former building where analyte was used or generated as waste
- ▬ Historical IHSS/PAC
- ▬ Pond
- ▬ Ephemeral stream
- ▬ Intermittent stream
- ▬ Perennial stream
- ▬ Site boundary



Scale 1:24,000
 State Plane Coordinate Projection
 Colorado Central Zone
 Datum: NAD 27

U.S. Department of Energy
 Rocky Flats Environmental
 Technology Site



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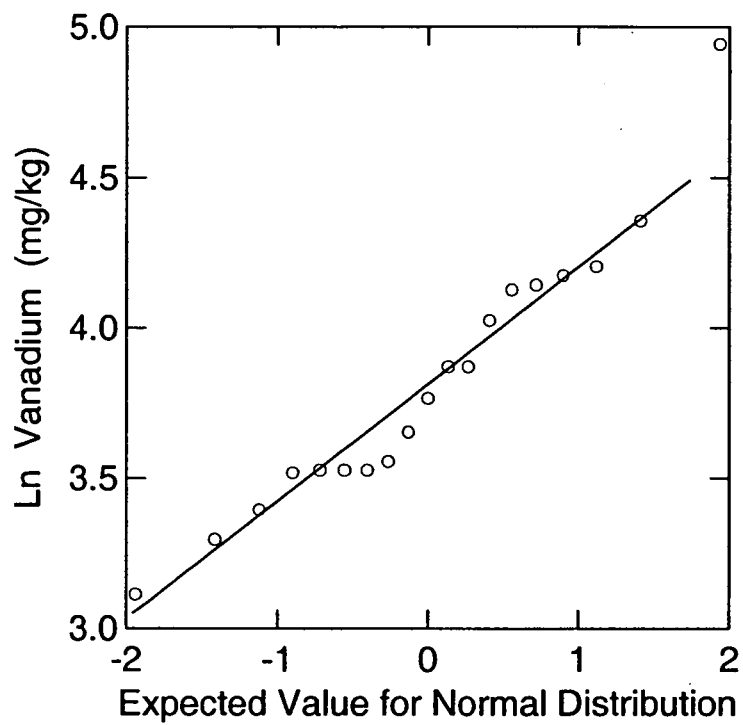


Figure A3.4.13. Probability Plot of Vanadium Concentrations (Natural Logarithm) in SEEU Surface Soil

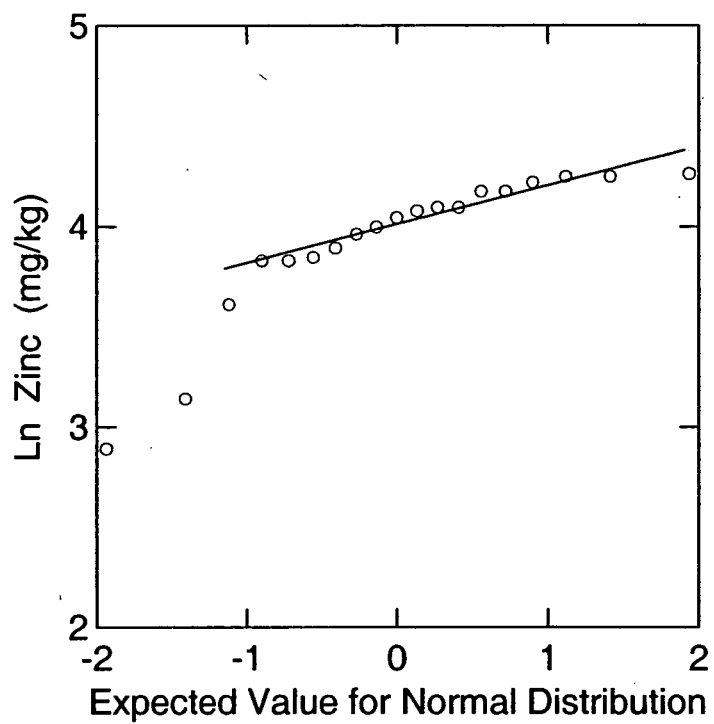


Figure A3.4.14. Probability Plot of Zinc Concentrations (Natural Logarithm) in SEEU Surface Soil

COMPREHENSIVE RISK ASSESSMENT

SOUTHEAST BUFFER ZONE AREA EXPOSURE UNIT

VOLUME 13: ATTACHMENT 4

CRA Analytical Data Set